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SCIENCE AND HUMANISM.[1]

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I have a feeling of rather dangerous temerity in attempting to discuss the subject of Science and Humanism, because I know perfectly well that systematic walling apart has made it the proper thing to talk about science to scientists and about humanism to humanists. The ideal talker is the man who, when talking to a mathematician, makes him feel that his is the real vocation, and when talking to teachers of chemistry and biology, that they are the only men of importance, or finally upon going into the English department, makes the members feel that here at last he has found a group who strike a really responsive chord in his soul. The great difficulty of my subject this morning is that it will not allow subtle camouflage of opinion. I am going to talk about humanism to a group interested primarily in science, which is a difficult thing to do. Therefore, I wish to ask you to help me; I wish to place some of the responsibility on your shoulders.

Now, I am sure that all of us realize that there are two main moods which persist through the whole history of intellectual life. Sometimes one mood is dominant, sometimes the other, and at times one flows like a great river beneath the surface only suddenly to crop out. I suppose we get it in a very primitive stage when in the sixth century before Christ, Thales attempted to explain that everything came from one. Doubtless he had observed that when you heat water something happens that causes the water to disappear, and he may have had some intimation of the fact that it existed in steam; he may have known that water was both solid and liquid. He wanted something by which he could explain everything simply. That is the mood back of all scientific thinking.

[1]Delivered before the General Meeting of the Central Association of Science and Mathematics Teachers, Lake View High School, Chicago, November 28, 1919.

In the fifth century B. C. Protagoros rose to declare that the individual man is the important thing. What is back of all this? One feels that even in this early Greek thought life had been solidified, and that the independent human spirit was trying to get a larger breathing space. It is the cry for the manifold.

Now, the scientists belong to the conservative group. With them it is uniformity rather than diversity. Through many long years there was a battle between the traditionalists and the scientists, a battle for freedom, but today you do not have to fight for a hearing, you do not have to do battle to get students to enter your classes. If there is anything that is obvious it is that the man who is teaching any science is teaching something that is needed. The world is waiting for what you are doing.

It is a wonderful thing to be connected with that type of intellectual activity which is working for a ripe world. The war produced a situation in which the men who had scientific knowledge were the valuable men. So that on the surface, at least, it is true that you have everything which could be desired. One of the old biologists tells that whenever he arrived at a place where he could go on he found a sign reading "No thoroughfare." You do not find this so today. Your battle for recognition has been fought and won. Today the teacher of science is the absolute king of the field. So thoroughly has this become true that we find a tendency to change humanism into science, a tendency to transform humanism into something that at least looks scientific. The ordinary teacher of humanism tries to explain that humanism is a kind of science.

Samuel Crothers wrote an essay on "Protective Coloring in Education." He says that if a man wants a hearing he must wear the protective coloring of science in order to get it. Now what is under it all? Is it true that it would be a good thing if humanism would disappear from the world? I know that if I were now addressing a group of old-fashioned English teachers, their faces would light up after this remark. They would feel that a champion for their cause had arisen. But from the standpoint of the teachers of science and mathematics, is it a good thing for the intellectual life of the world to have humanism disappear? Is life just a circle, the center of which is expressed by uniformity, or is life an ellipse, with uniformity as one focus and freedom as the other? If the whole life of man is a circle with uniformity as the center, then the modern scientific viewpoint is right, but if life is an ellipse, then without being in the least disrespectful, we do

need a readjustment of the meaning of free movement in the intellectual life of the world.

I wish, however, to pay my disrespects to the humanists. I know that often in humanism you have simple and irrelevant thought, failure to classify experiences, substitution of interest for truth and of camouflage for candor. You will see that I am not unaware of the weaknesses of that side. But will you be brave enough to let me say a word on the other side—on the weaknesses of the type of mind whose one emphasis is on uniformity? You will reduce life to an intellectual commonplace. That sense of freedom of movement will disappear from the world. Life will be reduced to something dead. I think a good deal of that sort of thing happened in Germany before the war. An insatiable desire for classification, unsurpassed in the whole world, but when finally tested, how impracticable it was.

The actual question is this? How are we going to keep our emphasis on law and uniformity and yet have that resiliency of the mind that will be capable of original inventive leadership in the world? I think the answer is the scientific humanist. Every teacher of science should be also a humanist, and every teacher of humanism a scientist.

Now it is very interesting to note the reaction of the world in the latter part of the nineteenth century. One of our great writers and thinkers came out and said that he believed in fairies. What did he mean by that sort of thing? He meant this, that he was so tired of a world completely mastered by uniformity that he was going to say just exactly what he wanted to. It was the cry for room. But if we want to get away from this intellectual anarchy, do we want on the other hand to become intellectual slaves? In other words, the only safe world is one in which you have uniformity believing in individual initiative. Where are you going to get your contact? I think one thing clearly represents the problem of the teacher of science. Take for instance, the men who are working in modern astronomy. In that field two distinct factors are brought into play: one is the physical formation that they discover; the other is the amazing freedom of the mind which made the discovery possible.

Now I know this is doleful, but it is true that today we have young men coming out of our colleges who can be trusted to collect and classify material, but when you ask them to sit down and project their mind into doing something beneficial to the world, you will find that these typical products are nothing but double-

entry bookkeepers, perfectly incapable so far as originality and profound leadership are concerned.

If this is true, then these things I have said suddenly become very interesting. Uniformity is a great thing, but if it reduces men to uniformness, it is a dangerous thing. What are we going to do about it? Well, I think there is just one thing but it is the really important thing. Take a teacher of science in a certain school or college who does take time to be interested in free play so that somehow he gives the impression that while it is true that man is in a vast network of law, there is nevertheless something in that man which can master and move freely the elements of law. When you get that humanism into science, you have a wonderful thing. I believe a man like this has the situation in his hands—a scientific humanist. He is a teacher who knows his particular field, who knows the sources—material and the total literature of his department; he is a man who has mastered what has been done and who has an interest in moving forward, but with all that he is finding time to pour into his life the richness of the great poetry of the world and the philosophical theories of life; and when he does that, two things happen. First, this miracle: he teaches science as if he were a humanist; and secondly, he produces a student who has in him all the uniformity which is the basis of science and all the freedom which is the basis of humanism. It is because you can do this that I have said these things so seriously to you this morning.

OIL DRILLING IN ALASKA.

The petroleum produced in Alaska is derived wholly from a single patented claim in the Katalla oil field, according to the U. S. Geological Survey, Department of the Interior. The old wells on this claim and the refinery were operated as usual in 1918. Two new productive wells were also drilled in the Katalla field. The total production in 1918 was somewhat larger than in 1917.

There has been a revival of interest in the potential Alaskan oil fields during the year in anticipation of the expected passage of a law providing for the leasing of the Alaskan oil lands. It is reported to the Geological Survey that investigations of the supposed oil lands on the Alaska Peninsula were made during the summer of 1918. No legal provision has yet been made for the leasing, and the Alaskan oil lands are still withdrawn from entry. There was some drilling for oil in the crystalline rocks near Cape Nome in the summer of 1918, but the results were unfavorable, as was to be expected. At Seward some interest was aroused over the discovery of inflammable gas issuing from the mud and water at several localities in the swamps along the railroad. The rocks near these localities, as described in 1915 by U. S. Grant, of the Geological Survey, are slates that have been metamorphosed and folded to a degree which makes it impossible for accumulations of oil or gas to be retained in them.

PRESENT NEEDS OF SCIENCE INSTRUCTION IN SECONDARY SCHOOLS.[1]

By ROBERT A. MILLIKAN,
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After more than two years of entire absence from the active pursuit of educational matters, it is a real delight to me to be back here in touch with our common problems. We are all exceedingly happy to be through with our war jobs and yet the war did one big thing for many, particularly for those of us who had the opportunity to be in the service with which I was connected, namely, the aviation service. It gave us a chance to get away from the details of our surroundings and to look things over from the point of view of the bird. And if we could glimpse our educational problems too from an airplane I think some of us would see things in a new light. I know that I am not expressing merely an individual opinion when I say that there is a general conviction that something more is needed in our science instruction in the secondary schools than we now have, and I want to give you in ten minutes here what I think this need is.

In the November number of *The Atlantic*, Mr. Dallas Love Sharp says, "We live on and learn, but the lessons from seventeen to seventy are only a review and an application of those from six to sixteen. In any rational survey of education, therefore, the higher schools and colleges are negligible. Our education as a people is that of the secondary schools. In them, more than in any other American institution, more than in all other American institutions, are the issues of an enlightened national life; issues no longer national merely, for the war has made them vital to the life of the world." Never were truer words spoken, and it is because I believe that they are true that I have come here to make a plea. But I wish to go a step farther than Mr. Sharp and consider what at least one of these issues is. I shall speak of only one, but that one is of paramount importance. It is the place of science in our educational scheme.

Everyone will agree that this is an age whose tap root is found in the sciences, that it is an age in which that nation which is most effective in ferreting out nature's secrets and in applying them to her industries and her commerce takes the lead in every line of human endeavor. And yet we in America have not begun as yet to awaken to our need and our opportunity. We are still

[1]Read before the General Meeting of the Central Association of Science and Mathematics Teachers, Lake View High School, Chicago, November 28, 1919.

scientifically asleep. We have neither as yet developed our proportion of outstanding scientists, nor have we cultivated as high a public appreciation of science as is found in most European countries, and as we must cultivate if we are to keep our place in the vanguard of progress. *We must look primarily to the secondary schools to change this state of things.* The time is more auspicious now than it has ever been for effecting a change. The great war has waked the world to the need of more thorough work in the sciences. Every man in the service found that he needed his science in order to get ahead. The industries are finding that they need it and are calling for men who know their science. I was in charge of the Meteorological Service in the United States Army, and we had many requests from colleges, universities and some secondary schools, asking what kind of courses should be given in order to train men for the Meteorological Service. We said, "Give them some fundamental physics and mathematics, and we will do the rest." Our manufacturers, a great many of them, are expressing the same point of view. I have talked with many of them. They say, "We want not so much men who are ready to be immediate producers in our industry, as men who have a fundamental knowledge of chemistry, physics and mathematics. With these as a basis we can soon teach the men what we want them to do." In response to this demand every university of which I know has nearly doubled this year the registration in physics and chemistry which it had before the war.

The time is ripe, then, for eliminating the weaknesses of our science instruction in the secondary schools, and a first step toward the solution is a recognition of what the weakness is. But this seems to me so obvious that it is almost trite to mention it. It is simply, as I see it, that the average pupil who goes through high school does not get enough fundamental science, and what little he does get is woefully superficial and scrappy; apparently it has become more so within the past ten years. I suspect that thoughtful men the country over are fairly unanimous in thinking that the whole of our secondary school work is in danger of becoming too largely a mass of *fragments* of knowledge, and so far as science is concerned, there is no doubt about it. We have been intensively pursuing what I called in an address before the Physics Section in 1916 the pellet method of instruction in science, and we shall continue to pursue it unless you or I or somebody gets hold of our principals and superintendents and

educational leaders and wakes them up to the tremendous need and the incomparable opportunity in science.

Need and opportunity for what? First, need and opportunity to get *consecutive, systematic, thorough* work in science in the high school. This is, I think, primarily a matter of *school administration and organization*, and I hope that some time principals and superintendents will wake up to that fact. So long as they continue to do what is called in the service "passing the buck" and put it all up to the teacher of science who is altogether helpless without them, no progress can be made. *So long as our elementary science is put up in tabloid form, by which I mean that the science is split up into yearly or half-yearly doses without antecedents and without consequents or continuity, we shall never have the most worth-while science in the public schools, no matter what the angle of approach, or what the arrangement of subject matter.* The crying need is not for a reorganization and rearrangement of the subject matter of science. That has been done and redone every year for twenty years to no avail and it will continue to be done to no purpose until we get a reorganization of the curriculum which makes it possible for the same group of pupils to get, say, *three continuous years of science.* The general science movement has, thus far, as I see it, been a step backward rather than a step forward, because it has intensified the pellet science evil instead of eliminating it. It is acceptable to principals and superintendents because it is the easy thing from an administrative standpoint to have no continuous courses at all, and it seems to some of us that we have in recent years been doing for the most part in our school organization the easy thing instead of the pedagogically sound thing.

Let me say in just a word exactly what I want to see tried out somewhere in the United States. It aims at two things primarily, which I will call *continuity* and *time-exposure* in science; incidentally, it aims at what the general science advocates want, namely, an interlocking of the sciences so as to break down the water tight compartment evil, but it does it without wasting a year of time and substituting a smattering of science for real science.

I want to see a group of students who plan to take a full high school course begin in the second year a three year course in the fundamental sciences of physics, chemistry and biology. During these three years the pupil would get the equivalent of one unit of each of these sciences, but each of them would be

spread over three years of time. The group would use any good physics text, for example, and would meet for physics but twice a week for three years, or during one of those years it might have but one lesson in physics per week. A precisely similar plan would be followed in chemistry and biology. It is very easy to forget physics, but I think if for three years you keep the subject growing in a pupil's mind, it is going to sink in. Here is where we get our time-exposure in all three of the fundamental sciences. We get continuity through having the same group going more deeply each year into each of the sciences and solving progressively more difficult problems. We get finally the interlocking of the sciences which gives a unity to the whole.[2]

The advantages are obvious and the general plan has been in use in Europe for years. What are the disadvantages? The principal says, "Administratively difficult." I think he overestimates the difficulty, but surely we cannot sacrifice the whole purpose of education to administrative simplicity. Keep, if you want to, your pellet science for the flotsam and jetsam of your school population, for those who want to come to school for a year or two and then leave, but at least do not sacrifice the man who wants a sound and thorough high school course to the convenience of the misfits. Is not that what we have been doing to too large an extent in the past?

The war has demonstrated the value of science, it has waked up some of our leaders to its possibilities, and has emphasized the necessity for thoroughness in scientific training. It has opened up the possibility of doing something constructive in the education of our whole people to the appreciation and use of science. I have wanted to present very briefly the big need, as I see it, because there is now such an opportunity to get something done as has never existed before. It is up to us science teachers to see that something is done, but in my judgment nothing really big can be done inside of the walls of the present organization of courses.

[2]The details of this plan are somewhat more fully elaboratd in "The Elimination of Waste in the Teaching of Secondary School Science" SCHOOL SCIENCE and MATHEMATICS, Vol. XVI, March, 1916, p. 193.

MINING IN THE FAIRBANKS DISTRICT.

The Fairbanks district, in the Yukon basin, has produced over $70,000,000 in gold and has been a source of considerable silver, lead, tungsten, and antimony. The conditions in the district in 1917 are reported in a paper by Theodore Chapin that forms part of Bulletin 692-F. Mr. Chapin gives an account of the operations at the gold and the silver-lead lodes and at the tungsten deposits.

THE RELATION OF VOCATIONAL GUIDANCE TO OUR TEACHING OF SCIENCE AND MATHEMATICS.[1]

By ANNA Y. REED,

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I am sure that all of us who have come here today have come with the idea of taking away with us something practical. Therefore, I shall say nothing on the theoretical side of the relation of vocational guidance to the teaching of science and mathematics, but shall proceed at once to the practical side of the matter.

Our department handles the placement work of all boys and girls up to twenty-one years of age, covering the high schools and to some extent the colleges. Quite recently I was in a Junior High School where the arithmetic lesson for the day was on the parcel post system. The teacher was not very much interested, neither were the children. They were using that arithmetic which is quite common in our schools today, the Walsh Arithmetic," and the more questions the teacher asked, the more it became evident that the period was going to be wasted. Seeing this, I felt justified in speaking to the children. I told a story to the boys and girls, and when I had finished, you could have heard a pin drop in the room. Gradually the children began to open their arithmetics and to ask questions. One boy asked if the lesson could be had over again the next day. The trouble was that there was no relation in the teacher's mind between that parcel post lesson and the use that lesson could be put to in outside life. I have had many boys lose good positions in the business world because they did not know the parcel post system, and when you come before a group of boys and girls and tell them this, you will get their attention. I have known of one boy after another who, because he could not master the zone system, lost his position. The employers say this: "We don't expect the boys to know the system when they come to us, but we do expect them to have enough fundamental knowledge to master the work in a few days, and we have these maps on the wall for them to use, but they don't do the work correctly and we discharge them." When I told the boys and girls about the loss of these good positions, they wanted to know something about the parcel post system, and those two or three

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pages of seemingly unimportant material in their arithmetics suddenly became very important. Now the relation between the parcel post system and the teaching of that lesson had been the difficulty.

Again, we send our girls out into the factories. The girls who pass through your training schools and home economics departments go out into machine operated factories to handle the making of garments. They will work a week or perhaps two and then come back to me and say, "I don't think I am getting a fair wage. Emma gets $18.00 a week for making buttonholes and I only get $9.00."

"What makes you think that your wage isn't right?"

"Why she made 3,500 buttonholes, but I made 2,000, and I think I should have a little more than half the pay she gets."

A girl of that type has no conception of the way a business man handles the mathematics of his business. She doesn't know what the word "overhead" means. Then I say to her, "Do you know how many buttonholes that machine can make under a skilled operator, that on days it is well handled it can turn out 4,000 buttonholes? Well, the girl who makes 3,500 buttonholes a day is a good investment from the point of view of the employer, because the overhead is covered. The fact that you make 2,000 buttonholes while she makes 3,500 has nothing to do with it. Your employer is wasting space by keeping you in his shop. In short, you are an expensive girl to employ at any cost. Instead of getting cheap labor, as you think he is getting, he is getting expensive labor."

In most of our arithmetic problems today there is no calculation in overhead, and our boys and girls should know these practical things. As a matter of fact, a girl who can make but 2,000 buttonholes a day is not wanted. Our girls do not know this, and they come back disappointed, because they have not been taught the relation between using their labor and the cost of it.

A teacher came into one of our offices four or five weeks ago in one of the large cities, and said to me that she had a very bright boy in one of her classes who had to drop out of school although he was only just ready for the eighth grade. She said he wanted to take up radio operating, and that she had advised him to put $100 into a course. She had tried to get him a scholarship, but was unable to do so, and the boy had made arrangements to pay for the course on the installment

plan. She asked if our office would take an interest in him. But it was too late to take an interest in him when the harm had already been done. I said to the teacher, "What do you know about the opportunities for radio operating today? Do you know anything about radio work? Don't you see that if you advise that boy to take up radio operating, having only been through the seventh grade, that you will handicap him from doing other things in the future?" She had no idea of the difference between ordinary radio operating and the higher lines of that work that an experienced and well educated man may handle. She was sending a young boy into a certain type of blind alley work. When I began to talk to her about the mathematics the boy needed and the limitations of a seventh grade education, she was not so confident. I said to her, "You should have given this boy all the information available on radio work and on the requirements in sciences before you let him put $100 into that course. Did you consult anyone about it?"

"Oh, yes, I went to the radio school, and they said that the boy didn't need any more education than he had."

"Don't you see," I answered, "that it was to the advantage of the radio school to say that? They had no personal interest in the boy. All they wanted was the $100 for the course."

In that teacher's mind there was no relation between vocational guidance and the teaching of mathematics and science. She thought she was giving this boy first class advice. When is the time coming when teachers will be able to handle these problems?

A boy came into one of our offices recently, and said to me, "Mrs. Reed, I am afraid I am not going to like that position."

"Why?"

"Well, I went in with the understanding that I was to be employed seven and a half hours a day, and I have only worked one day and they kept me half an hour overtime."

"What were you doing?"

"I was in the shop. The manager was going over some details of the work with me."

"How much work did you do?"

"Oh, I didn't do anything very much. The owner of the plant was there too, and he and the manager were talking and sort of outlining the work for me."

"These men stayed half an hour overtime, too?"

"Yes."

"They were explaining the work to you and showing you how it could best be done?"

"Yes."

"When you took that position you took it at the same salary of the man who had the position previously and who knew all about the work. Has it occurred to you, young man, that the people who were working overtime were the owner and the manager?"

He hadn't thought of that. Yet the boy had been through a good high school. He thought that every minute he was in that plant overtime was to the advantage of someone else. He did not know that every time a man is taken in at a salary the same as the person who left received, he is being paid for something he does not earn until he fully understands the work. I said to the boy in question, "Go back and you may amount to something a little later in life." He was a rather old boy to just learn the practical side of work.

Again, we had a boy who went through the eighth grade. He is now twenty-five years of age. During the war the opportunity for great progress came to him, but he was handicapped for life because he did not have the related subjects to put himself ahead. When I first knew him he was working in a chemist's shop. I asked the owners if they would also take a young college boy into this same shop. They said, "We don't need him. It is the dull season. All we could offer him would be an office boy job at $30 a month. An uneducated boy would do just as well." I asked the college boy if he wanted the office boy job. He said he would take it, that he was anxious to know just what were the duties of an office boy in a chemist's shop at $30 a month. At this time the boy I spoke of first was earning $75 a month, which was then a very fair salary. The two boys worked together. The college boy swept the office, and afterwards went out soliciting orders. Then he went down into the plant to do odd jobs. When he saw the $75 a month boy sitting on a stool waiting for a repair man to come to fix one of the machines, he said, "What is the use of our wasting our time? Why not fix the machine ourselves?"

"Oh, no, we always send for a repair man."

The college boy, however, went to work and with the knowledge he had acquired in shop work at college he repaired the machine. Before long he became familiar with one or two other lines of work. When the firm received a large order for

creosoting they found that none of their men knew anything about this line or work. The president called the young college boy to him and said, "I am greatly surprised to see how many lines of related work you are familiar with. I wonder if you could prepare yourself sufficiently in two weeks' time to enable us to take this creosoting order? Can you handle the work?" The college boy said he could, and he went nights to his college library and read all the available information on this subject. His firm took the contract for the work and it was done successfully. His salary was raised to $100 a month. The $75 a month boy was still getting $75 a month. Soon after, this $75 a month boy came to me and said, "My firm wants me to do some work in which I have to compute a square. I don't know whether this requires algebra or geometry." This boy could not get ahead because he knew nothing of the related subjects required in the work he had chosen. None of his teachers had told him that that there was a limit to what he could do in chemistry if he didn't have the related work. When the war came the college boy went right to the top with a high salaried civilian position, while the other boy went into the draft, handicapped for life.

Our employment offices are full of reports that show that there is no relation between the subjects of mathematics and science and their use in after life. I am telling you these stories not just to interest you, but because I feel that they will cause you to modify your curriculum so that it will be more practical, so that the avenues of education will be broader. At the present time your teaching of science and mathematics is not being done under the most favorable conditions, because you do not know the facts of industrial work as well as you should know them. I don't see how a man or woman can be in a school building all day and know very much about industrial work, but I blame you because you do not demand that there be a source for ascertaining information that will help you to tell your boys and girls what they need. Fifty per cent of the failures of the boys and girls who come from our public schools are due to things that could have been remedied. This is a general statement, of course, but I have kept as careful a record as I could of the failures of boys and girls, and as nearly as I can estimate, fifty per cent of these failures are due to conditions which could just as well have been remedied had the public schools done their share. Seventy per cent of the turnover of our young people is absolutely useless, and fifty per cent due to the fact that there is no relation between

vocational guidance and the work done in our schools. Isn't this one fact enough to make us realize that this is an important thing? And yet we have been fooling with vocational guidance for fifteen years, without founding practical avenues wherein to obtain practical information. I don't think it makes any difference what I may know that would be of value if you do not take that knowledge and put it into your schools. The responsibility lies first on the educator to know the facts of industry and thereby help the boys and girls to choose the right subjects in school. After this comes the work of vocational guidance for vocational educational purposes, and finally comes the work of the employment service which is to take the product of our public schools and so help them to use their talents that they may be best placed. The next step is the returns on placements which come back to us. We hear this, "I think that if the public schools had done their work better we would not have had so many failures." Then the business houses securely file away all the information they have on the subject. It doesn't occur to them that this information belongs to us. If we are to be successful in placing our boys and girls in the business world we must have the cooperation of everyone concerned. We cannot do this work alone.

During the war there were many young women who wanted positions as chemists. We couldn't place them because they didn't have physics. Many firms wanted a combination of chemistry and bacteriology, which these girls did not have.

Recently women have gone into engineering, but they have not been successful. Upon inquiry employers tell me that these women will not be kept permanently, for, although they can do drafting, they can do no layout work. Yet I find many advisers for women in our colleges who say off hand that there is plenty of opportunity for women in engineering. The women who have gone into this work are not going to reach the top. They are going to keep the lower positions, because women have not made good in this branch of industry. When our girls come to us and say, "I was offered $80 while a man was offered $120 and I believe in equal pay for equal work," we can be sure that there isn't any equal work about it. In engineering, women are not hired to do the same kind of work that men do. A firm will not take a man in at $120 unless it feels that he soon will be worth more. Firms do not feel this way about women. Here

and there, of course, women have made good in this line, but that is exceptional. Women are still regarded as business risks in engineering.

I think that we should have some scheme whereby our boys and girls may test the various occupations in a general way. There are many simple tests that can be taken into the high schools that will enable the boys and girls to discuss each industry and see what there is in each industry for them. I took up a test of this kind the other day at the Normal School. The principal was very anxious to have his teachers get some practical methods. I said I would take all the Junior High School students and that I would try to give a model lesson. I asked each boy and girl to keep in mind some definite occupation that they would like to take up when they grow older. There were more boys who chose science than there were who chose anything else. When the question of skilled, semi-skilled and unskilled labor came up, it was marvelous to see how these boys grasped the idea that it was their previous preparation which determined into which group of labor they would go. One boy came to me afterward and said that he had intended to leave school at the end of that term, but that he was afraid now if he did so he would get into the unskilled class. With these tests we can give your boys and girls a good general background.

The average teacher does not know enough about industrial work to advise the pupils. We must have men and women who are paid just for concentrating on this subject, and who will come back to you to answer questions that will help you. I hope that we shall soon be able to combine this work with education, so that it will mean much to educators of our country. I hope that the educators will soon realize that fifty per cent of this work is their responsibility. The question is often asked, "Does this work belong to the Department of Labor or to the Department of Education?" I don't know. I don't think it makes any difference, but unless fifty per cent of the responsibility is taken by educators it is going to be a failure. Are you prepared and are you willing to lead in this matter of vocational guidance and placement? We have been fooling, as has been said, for fifteen years without accomplishing much. As an example, in one of our large cities I recently heard the boast that there had been 1,800 boys and girls placed in positions within one year. I said, "Do you realize that if you met the requirements of your city that you would have placed 18,000?"

Vocational guidance and placement means the opening of a new avenue in education. If we have an employment service in Chicago, it will mean that when we send word to you that over here is a business house which is going to discharge a boy because he can't read blue prints, and in another place are several boys who can't be promoted because they are unable to read blue prints, it will mean that you will have to take these boys and say "You will be able to read blue prints before we get through with you." Unless you do this, you will be missing one of the greatest opportunities in education today. Again we may send you word that there are fifteen girls who are failing as stenographers because they are not speedy enough. It is your business to take these girls and place them under a special teacher who will drill them on speed alone until they come up to the standard. This work is fifty per cent education and fifty per cent employment. It is the type of work that will do more for the business houses and more for our boys,and girls than any other thing. It will do away with much of our present labor unrest and the feeling among our young people, when they have drifted about for several unprofitable years, that the world owes them a living.

WATER SUPPLY FOR SAN DIEGO, CALIFORNIA.

Practical Problems of a Romantic Playground.

One of the popular playgrounds of the United States lies around San Diego, Calif., in the extreme southwest corner of the country. The mild, healthful climate, the beautiful scenery, and the romantic historical associations of this out-of-the-way yet readily accessible region give it a peculiar fascination that is attracting to it from year to year an ever-increasing number of tourists and permanent inhabitants. Here a narrow belt of lowland and "mesa" is bathed on one side by the Pacific Ocean and bordered on the other by a mountainous highland from the summits of which magnificent views stretch to the Pacific on the west and to the Salton Sea and the Colorado Desert on the east. Excellent automobile roads lead from the seashore to the mountain crests and connect all parts of the region with Los Angeles. Travelers along these roads can see the old Spanish missions, the ruins of primitive irrigation systems built long ago by Franciscan monks, numerous quaint old places, and humble villages inhabited by Indians.

San Diego is not only the center of a fascinating national playground but the center of a rapidly increasing commerce. Its excellent harbor is the first one in the United States to be reached by west-bound ships coming through the Panama Canal, and a new railroad, now practically completed, connects it directly with the thriving agricultural districts of Imperial Valley and Arizona.

The resource that is most essential to the development of this district is water. Nowhere else in the United States is water more valuable than in the vicinity of San Diego, and perhaps nowhere else have more resolute efforts been made to conserve and utilize it.

AN OLD FORM OF TOP REVIVED.

By Chas. T. Knipp,
University of Illinois, Urbana, Ill.

The top described in this article was made in Ohio over forty years ago by a country-side cabinet-maker. It appears that this form has neither been described in any of our scientific journals nor mentioned in books descriptive of tops and gyroscopic motion. Its spinning qualities warrant giving it a brief description here.

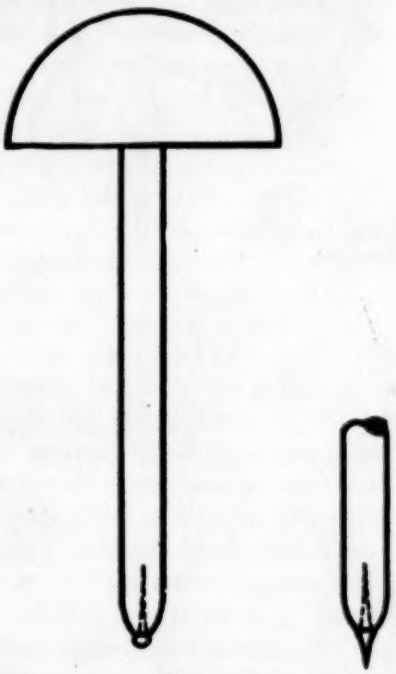

Fig. 1.

The top proper is illustrated in Fig. 1, which is full size. It should be turned out of tough wood, preferably maple. A smooth round headed tack is driven into the foot of the leg, as shown in the figure. A second top with a sharp tip should also be provided.

To spin either, a strong slender string and a special holder are necessary. The latter may well be a piece of poplar wood having dimensions of about ¾x1½x5½ inches. Through one end of this holder a half inch hole is bored, while the other is partially turned down for a handle. The top with the string wound on its leg, inserted in holder ready for spinning, is shown

in Fig. 2. The string should be wound solidly on the leg (single layer) from the tip up to the head. To prevent the top from slipping bodily out of holder before it is completely spun, and to insure maximum speed, the holder must be tilted slightly away from the line of draft of string. These points are shown in Fig. 2.

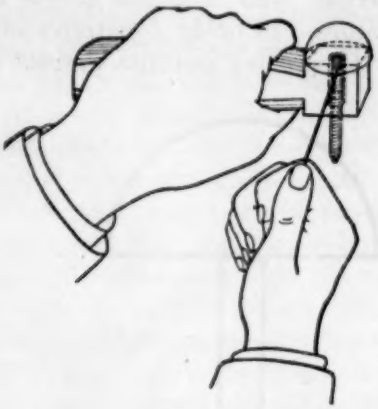

FIG. 2.

With the holder firmly gripped by the left hand, spin the top by pulling steadily and quickly on the string with the right hand. The string as it unwinds will lift the top out of the holder, the top dropping to the floor, spinning most beautifully. After several trials the operator will feel safe in imparting greater and greater speed to his top, fairly making it hum.

Aside from being a toy, this form of top may be used in illustrating the principles of gyroscopic motion. Possibly the most striking example is to note how quickly the spinning top will "go to sleep." For this purpose use the one with a smooth round tip. When spun, the axis quite likely, when the top strikes the floor, will be inclined at an angle to the vertical. The top will at once begin to precess (swing around) about this vertical, and will almost immediately erect itself and spin on quietly. It does not matter at what speed the top with a round tip is spun, it always erects itself, and at the end of the run it will "die" very quickly.

The counterpart of the above experiment is to spin the top having the sharp tip. Again, as it drops to the floor (or table) its axis will, in general, make an angle to the vertical. It will be noted that though the axis in this case precesses as before, it now remains at *constant* angle to the vertical throughout the time of vigorous spinning,—the top will not erect itself, and, at the end of the run, will die slowly.

The explanation of the behavior in the two cases just enumerated is found in books on gyroscopic motion.[1] Briefly, in the case of the round tip there is rolling motion on the floor which causes a component being formed that tends to tilt the axis towards the vertical. In the case of the pointed tip there is little or no rolling motion, hence the vertical component is lacking, and the top does not rise.

Another interesting point that may be illustrated is, that the axis of the spinning top tends to remain parallel to itself while spinning in mid air. Spin the top (having the round tip) vigorously, so that when it leaves the holder its axis makes an angle of, say, 45° to the vertical. If the speed is great, the top will bounce about like a rubber ball, the axis all the while remaining parallel to itself. However, as soon as the top settles down on the floor, it begins to precess, rolling friction comes into play and the top erects itself.

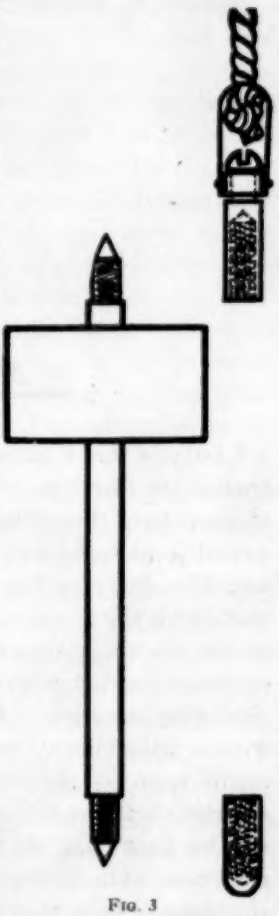

FIG. 3

It should also be noted that the top with the sharp tip may not remain "put" in case the floor is very smooth, but persists in precessing about its center of gyration, i. e., the leg sweeping in a wide circle about the vertical axis.

For a more extended study of the effects of round and sharp tips, as well as the effect of transferring the point of support, metal tops, such as sketched in Figs. 3 and 4, may be used to advantage. A metal top with its interchangeable tips and swivel support is shown in Fig. 3, which is drawn full size. The body is made of brass and the stem of twist drill steel rod. The stem extends through the head of the top and has a sharp tip at either end. These tips should be case-hardened. A steel cap with a round tip may be, in turn, screwed on either end, thus converting the top from sharp to round tips and vice versa.

[1] *Spinning Tops*, John Perry, London. *Spinning Tops and Gyroscopic Motion*, Harold Crabtree, Longmans, Green and Co., New York.

The holder for spinning is the same as that used in Fig. 2. The metal top, because of its greater momentum, spins correspondingly longer. When spun on the short leg with the round tip on a smooth (waxed) floor it will go to sleep with ease for five minutes. To spin on its short leg it is only necessary to turn the top upside down in the holder, tilt the axis *towards* the operator, and pull on the string steadily and quickly.

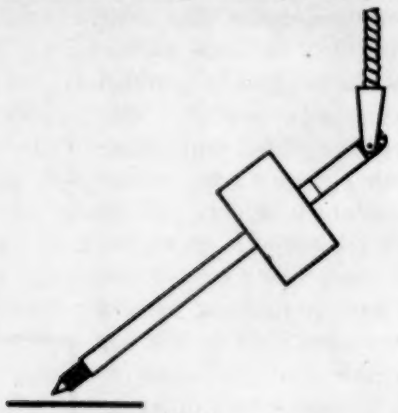

FIG. 4

Lastly, a most interesting experiment, showing the dependence of the direction of the precessional motion upon the manner of support of the spinning top, may be performed by providing a swivel joint to be screwed on the short leg, the construction of which is shown in Fig. 3. By reference to Fig. 2 it will be seen that, with the string wound as shown, the top when spun turns in the clockwise direction, looking down from above. Its precessional motion when spinning on the floor will also be in the clockwise direction. If now the top be supported by the swivel with a rather heavy cord attached (to prevent winding up), and again spun in the clockwise direction, it will precess in the *counter clockwise* direction, and if lowered so that the tip rests on the floor (Fig. 4) the precessional motion at once becomes *clockwise*. On lifting it off the floor it again becomes *counter clockwise*. This experiment works best with the pointed tip, the round tip causing the top to erect itself so quickly that the precessional motion is lost to view. Of course, if the top is spun in the reverse direction, the precessional motion in each case will be reversed.

Other uses to which this form of top may be put will suggest themselves to the operator.

WHAT CHANGES SHOULD BE MADE IN OUR METHODS OF TEACHING HIGH SCHOOL GEOGRAPHY?[1]

By W. R. McConnell,
Miami University, Oxford, Ohio.

Fifty years ago there were but forty public high schools in the United States; today there are over twelve thousand. Along with this tremendous increase in public high schools during the last half century has gone a very much changed conception of the function for which the high school exists. It has not been long ago that public high schools were attended chiefly by those who were on their road to college. The high school was thought of as being one of the stages through which those and only those travelling toward college need pass. But now hundreds of thousands of young people, who have no prospect whatsoever of continuing in higher education crowd the classrooms of our public high schools. I believe that the proportion of those who complete the high school and later graduate from college is about one out of eight. The American high school has become in reality the university where all the children of all the people may attend and from it receive whatever it has to give them. From it they go with as broad an outlook upon life as it has opened up to them.

Now it is quite obvious that this great enthusiasm for secondary education in America, backed as it is by public opinion throughout the land should attract the attention of our ablest educators and challenge them to thoughtfully consider the aims and purposes of high school instruction. How may the high school best serve the interests of the hosts of young people who are today attending it?

There is today among those who have at heart the shaping of educational thought in this country a rather general agreement as to the fundamental aims of secondary education. Briefly stated it is that the student should undergo those experiences in the high schools that will tend to make them good citizens. To train for citizenship is the primary purpose of secondary school instruction. "Citizenship" is thought of in terms of socially useful ends. Boys and girls are to be prepared for personal usefulness in a modern world. As life in our modern democracy becomes more complex there is a constantly increasing need for a greater amount of common knowledge which the elementary school is inadequate to give because of the age of

[1]Read before the Geography Section of the C. A. S. and M. T., Lake View High School, Chicago, November 28, 1919.

the pupils. It is during the high school age that young people can put away childish things and intelligently appreciate the interests and activities of men and women and by assisting and stimulating boys and girls to take an intelligent and helpful interest in the performance of duties and responsibilities that will come to them in their lives as future citizens the public high school may become the greatest quickening and unifying force in American life.

Once the aims of high school education are established it, of course, follows that attempts will be made to fashion a curriculum that will get results. If the high school is to make good citizens then the curriculum must give such training as will assist in the performance of duties as future citizens.

It is quite obvious that those who agree upon a fundamental aim of high school instruction will differ greatly in their opinions as to what should be the specific experiences that will make for good citizenship. The high school curriculum must and should for a long time to come be in the making. The subjects of study and the methods of presenting the material must ever be uppermost in the minds of those who are charged with the special mission of fashioning its curriculum so as to make it an agent of the greatest usefulness.

If geography is to have a place in the high school curriculum it should be there because in its study boys and girls go through experiences that will make them better citizens. If geography or any other study is to remain in the high school curriculum it must do so because it is justified from the standpoint of educational aims. Then and not until then will geography be ready to play the part which it should have in the training of the young people of America. The geographer and the educator must come to know each other a great deal better in the future than they have in the past. It is our educational leaders who formulate the aims of education and in a large measure shape the curriculum rather than one interested in any special subject of study.

Twenty-six years ago a committee was appointed by the National Educational Association to reorganize the high school curriculum. Among other things in its report this committee recommended a year of physical geography as an introductory science course in the high school and in their argument for it stated that it offered special opportunity for training the powers

of observation, the scientific imagination and the ability to reason.

I do not care to go into a lengthy discussion of educational theory but it behooves every teacher of geography at this time to earnestly inquire why it is that geography is not in the high schools today to any thing like the extent that it should be despite the report of this able committee. Some may argue that it failed because of inadequately trained teachers, but I am inclined to think that its place in the high school curriculum was questioned because the argument of the committee for its being there has been found to be based upon unsound educational doctrine. It was based upon a belief in the so-called "doctrine of formal discipline" or the transfer of training—a belief that training in observation or reasoning in one subject of study will carry over into and function in all other fields of knowledge or action.

Since this report in 1893 educational theory and practice has gone on a long journey and along its pathway lie many discarded notions among the rubbish of which may be found the whitening bones of the doctrine of formal discipline when it is thought of in the sense that the "committee of ten" were without doubt thinking.

Another report of a committee on secondary education in 1909, realizing that pure physical geography could no longer be defended, recommended "that about one half year be devoted to the larger topics in physical geography with the human side made more prominent than at present and that the remainder of the year be given to a study of North America and Europe." Since this report in 1909 the geography work in high schools has drifted. It has seemed to lack unity or purpose, and in many schools it was dropped from the curriculum and general science has occupied the place once designated for geography.

Geography has failed to secure a more prominent place in the secondary school curriculum because it has not responded to educational demands. Its content and above all, its method of presentation has changed but little during the last decade. Students are still memorizing facts and principles isolated from all significance and from all relationship, and where laboratory work is offered in the subject it has, in too many cases, become a mere liturgy.

Other subjects of study have responded to new occasions and new duties. There is, for example, today, a new history, a

history in which the human activities of the past are portrayed against a background of geographic conditions. One of the most used texts in the high school history classes of today is to a considerable degree a text in applied human geography. One who has the interests of geography at heart and who is aware of its possibilities and of the pressing need of more geographical knowledge cannot read a modern high school history without feeling that geographers are sinning away their day of grace.

In the history text to which I referred one finds a discussion of such subjects as the "Woolen Industry," "The Iron Industry," "Transportation," the "Conservation of Natural Resources," and many other similar topics. I am not saying that these topics should not be in a history text book. They are just the things that should be taught to American boys and girls of high school age and I am glad that they are taught in some degree at least, in some connection. But whatever historical aspect these subjects may have must be closely interwoven with basic geographic considerations which must be taken into account in any historical treatment of them. If these subjects had been adequately taken care of in the high school geography class they would not now receive such extensive treatment in our history text books and what historical bearings they have would be much more intelligently interpreted. Such geography as is now found in these historical texts would receive the sanction of educators. There would be no struggle for its existence in the curriculum. We would all understand that there was no conflict between geography and general science but rather that general science was an aid to the study of geography just as it is an aid to chemistry and physics and other science courses that come in the later years of the high school course.

In the history text to which I have referred there are maps of the cotton belt, our coal and iron ore deposits, the distributions of manufacturing, and the forest regions of United States. There are more and better railroad maps and transportation maps of the world than are found in most of our modern texts in geography. In the questions and exercises at the close of the chapters one finds such as: "What conditions in Europe combined with the geography of the regions settled in America tended to make the French and English colonies in America quite different?" "Why was the site of Pittsburgh an important point in the struggle of France and England for supremacy in America?" "Why were the northern colonies more actively

engaged in shipbuilding than the southern colonies?" "Why did Pennsylvania become the center of the iron industry?"

Thus while those interested in geography have been talking and vacillating and spending years in pusillanimous delay in debating general science versus geography in the high school curriculum there has grown up a new history which understands and appreciates the influence of geographic environment on the life and activities of people. But certainly no intelligent writer of history would assume that high school pupils are in possession of enough geographical knowledge of any particular region to correctly interpret the history of that region. In working out any one of the exercises mentioned above, as for example, "Why did Pennsylvania become the center of the iron industry?" the teacher of history would find it necessary to thoroughly teach the geography of Pennsylvania and its environments and to read the answer to the exercise in the light of that geographical knowledge. But should the teacher of history teach the geographic background of such an exercise or should the geography teacher do it? Why should not the geography teacher teach the history that is written on a geographic background? Why should not the teacher of high school geography also handle the history work done in the high school, particularly the courses in industrial history?

Geography teachers have long talked about a "human geography," but, I suppose, having so recently inherited our ideas from the school that just preceded this generation, it is but natural that we should revert to the type and feel that we are not teaching geography unless we are drilling our pupils on some phase of physical geography. A very common method of deluding ourselves into a belief that we are teaching applied geography at the present time is to drill on geographic factors or principles or "controls" and then go over the world conjuring into existence conditions, some real and some imaginary, in which the factors or principles or controls are seen in action among people and then wonder why educators should not see why geography should be in the curriculum of the high school. What we have overlooked is that the factors and principles may be taught by beginning with human activities and interpreting them in the light of adjustment to geographic environment. We have dealt with such topics as "Mountains in their Relation to Human Life" rather than "Life in Eastern United States as Influenced by the Appalachian Mountain System." We have

taught "Plateaus and Plains and their Relations to Life" rather than to contrast life on the Atlantic coastal plains with life on the Piedmont region. We study the influence of mountain passes rather than "American History as Influenced by the Hudson-Mohawk Gap." We study the "Climatic Influences of Lakes" rather than "The Fruit Industry of Western New York or Michigan." We have been content with giving isolated examples of geographic influences in various regions rather than to study in detail the life of any particular region and interpret it in its relation to geographic environment.

Geography straddles two sciences. It is the link between the social and the natural sciences. On the side of content it belongs in a group with history, civics, political science, sociology, and commercial and industrial education. All of these subjects aim at adjusting man to his environment, and unquestionably such studies are destined to occupy a space of ever-widening dimensions in the high school curriculum. Such studies supply the basis for sympathetic social cooperation.

Regardless of where geography may get its data, its basic point of view is social. Sympathy and genuine interest in other people which leads to cooperation with them has its foundation in a knowledge of their general surroundings and activities. Our degree of interest in other people is almost directly proportionate to our knowledge of them, how they are living, what they are doing, what economic and social problems confront them, and how they are equipped to handle these. During the war we found it necessary to enter into sympathetic cooperation with other people living in a different environment than our own and one of the chief effects of the war upon geography was to enhance interest in it. Teachers of geography can ask themselves no more important question than "Shall that interest continue?" Surely it was demonstrated that a knowledge of geography is necessary if one is to keep in touch with the large and influential elements of modern life. Geographic ignorance today means that one is living as a stranger in a strange land. This is not because he has failed to memorize a certain number of facts or principles but because he cannot intelligently interpret the activities of various groups of people.

The field of geography is the social, political and business life of the world. The controlling aim in teaching it should be to know people, to understand people and to appreciate people not as individuals but as groups occupying the various nations of the world.

The teacher of high school geography, realizing that his aim is to teach the pupil to use his mind in working out problems in the fields of knowledge that will confront him as a citizen, should ask himself: "What are the problems which the everyday man is likely to meet that will have to be solved through a knowledge of geography?" Physics is no longer taught for the purpose of training the mind. We teach it for its practical value and trust that in the process of solving practical problems where a knowledge of physics is needed the mind will be trained in a method of attacking all problems of a similar nature. In the same way and for the same ends should we teach geography. The kind of geography needed is that which will aid in a solution of problems arising in connection with such things as industrial legislation, banking and finance, supply and demand, reciprocity, free trade and protection, and practically all current international questions, a knowledge of which is fundamental for intelligent and responsible citizenship. It is the business and the privilege of the high school teacher to teach the geographic factors involved in situations arising from such vital issues. The problem of Japanese expansion, the Irish question, Polish agitation for Upper Silesia and Lloyd George's boast that the Allies have annexed six hundred thousand square miles of German territory are concrete examples of topics suited for the modern high school geography class.

The kind of geography that should be taught in the secondary school, then, should be neither physical geography nor commercial geography but it should be applied regional geography, a study of the geographic factors that enter into the historical, economic and social life of the people of the various countries of the world. As Dewey, in his book *Education and Democracy*, has pointed out, separate phases of geographical study are not to be adjusted by an external compromise that crowds so much material into each of them, but it must be constantly borne in mind that the educational center of gravity is in the human aspects of the subject. "From this center," says Dewey, "any material becomes relevant in so far as it is needed to help appreciate the significance of human activities and relations." Thus has one of our greatest educators set up a working definition of geography, perhaps the best that is found in modern literature.

I have said that our high school geography should be regional. The region need not be a physiographic province, and it certainly should not be a continent as a whole. It may well be a

section having similar trade and industrial interests, as for example "Eastern Canada" or "The Mediterranean Lands," or it may well be a nation. There is much argument in favor of taking the nations as units for study. It is imperative in these days that we should know humanity as divided into nations, what a nation is, how many nations there are on earth and their distribution. It is important that we know in so far as possible the character of each of these nations: its customs, its interests, its weaknesses and its strength, its international relations and what hopes and fears it justifies. These are the things that a good citizen should know and the high school geography class should contribute its share (and it should be a large share) toward giving this information. If, for example, we are to live peacefully with Mexico it will be necessary for us to visualize the Mexican people and know how the Mexicans are living, the kind of environment they have to work with and the future possibilities of such an environment.

We should do more with the problem method of teaching than has been done in the past. Its use is a movement in education of great significance. Educators are favoring a wise use of the problem because it leads to the selection and disentanglement of primal factors in a situation and aids the teacher in bringing into the focus of conscious attention basal facts and principles which would otherwise be lost in a mass of irrelevant detail. Our text books will be properly used when the material in them is made use of in the solution of some vital problems.

If those who have the opportunity of teaching high school geography will teach applied regional geography and make free use of carefully thought out problems in presenting their lessons it will go a long ways toward securing for geography the place that it should occupy in the modern high school curriculum.

ALASKA PRODUCES TIN.

The tin mines of Alaska produced 136,000 pounds of tin, valued at $118,000, in 1918, according to the U. S. Geological Survey, Department of the Interior. These figures may be compared with 200,000 pounds, valued at $123,300, in 1917. The decrease in output in 1918 was due to the fact that only one dredge was operated. Additional tin, however, was recovered by sluicing. The first important production of Alaska tin was reported in 1902, when the output was 15 tons. Since 1912 the average has been over 100 tons annually.

The recent discovery of placer tin has been reported from Potato and Humboldt creeks, on Seward Peninsula, and from Moran Creek, a tributary of Melozi River, where the gravels are said to contain 2½ pounds of tin and 10 cents' worth of gold to the cubic yard.

CORRELATION OF MATHEMATICAL SUBJECTS.

By E. R. Breslich,

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In the traditional high-school courses the various subjects of mathematics are taught separately. Algebra is usually taught in the first year, plane geometry in the second, and advanced algebra in the third. These are followed by courses in trigonometry or solid geometry. Leading mathematicians and professors of the teaching of mathematics in England, Continental Europe and in America have long recognized the relationship between the subjects of secondary mathematics, especially algebra and geometry, and have advocated with emphatic presentation of detailed reason the desirability of teaching them together. Teachers have also felt that better results could be accomplished with the high-school pupil by correlating these subjects. However, this movement for correlation has been insistently opposed by those who fear that it may ultimately result in a complete "fusion" which in turn may lead to "confusion" on the part of the pupil, and by the owners of traditional textbooks.

In making important changes in a traditional subject such as mathematics, historical considerations are not to be disregarded. Particularly, one should study the question whether the present high-school courses in mathematics are the outcome of a broad, well-conceived plan so organized as to accomplish the aims and purposes of present secondary education. We find that among the subjects studied by the ancient nations geometry became early a highly developed science. The speculative mind of the Greek, disregarding the practical phase of Egyptian geometry, changed the study of geometry into the form of a liberal education. At the time of Pythagoras it was a flourishing science. Later it was transferred to Egypt, the land of its origin, where Euclid gave to the world his book on geometry, called the *Elements*. In this he formulated a system of geometry which to the present time has practically remained the same. Its main purpose was not to give training in space relations, but to serve as a study for the adult mind. It continued to be studied because of its logical form, which was supposed to be perfect, and because of its supposedly great value as a means of training the mind. Being an advanced subject it was transferred to the upper classes when taken into the high school. Hence we find in our modern educational system little or no instruction in space relations until

the pupil reaches the second year of the high school, or until he enters a course in solid geometry. Since the proportion of pupils reaching these courses is relatively small, the large mass of children get very little experience with space relations in their school work, unless they pick it up outside of their courses in mathematics.

The Greeks, who contributed so much to the development of geometry, did very little for arithmetic and algebra. Their system of notation was very clumsy, making operations in arithmetic exceedingly difficult. Toward the close of the twelfth century, however, the arithmetical and algebraic knowledge of the Arabs was brought to Italy. Because of its good notation, which is essential for proficient work in numbers, it was readily accepted. Through Rome it passed into the curriculum of mediaeval Europe. Spreading rapidly, at the end of the thirteenth century Arabic arithmetic had been fairly introduced into Germany, France and England. Since algebra had its origin in arithmetic it flourished with the development of the science of arithmetic, and since arithmetic took a low place on the curriculum, algebra, with its exceedingly difficult abstractions, also took a position lower than geometry.

Evidently the fact that algebra precedes demonstrative geometry in our high-school courses is not part of a carefully considered plan. It is a historical accident and in spite of the fact that a large percentage of pupils fail to master it, algebra still retains its position.

Some schools, feeling the need of giving the pupil training in space relations before he takes up the study of algebra, have tried to find a remedy by teaching the two subjects in the reverse order. This plan has not been successful. For, in both courses many pupils lose their hold early and after that profit little by further instruction. Either plan overlooks the facts that algebra and demonstrative geometry both involve abstractions which are exceedingly difficult for the pupil of the early high-school period, unless a wide experience with the fundamental concepts precedes, and that they contain simple and difficult facts which should be so arranged that as far as possible the simple fact be taught first. Such a psychological arrangement leads to a breaking up of the historical lines of division and to a correlation of the two subjects.

Another effort to get a psychological arrangement is the plan of teaching each subject on certain days of each week. Algebra

is taught two or three days and geometry for the remainder of the week. This plan has not been popular among teachers and pupils. For, the pupil has to carry two textbooks and is continually confused as to the lesson assignments. The abrupt change from one subject, at a time when everybody seems to be interested, to the other, jars both teachers and pupils. The plan is not economical as to time because an interruption of several days during the study of a topic makes a review necessary when it is again taken up. The solution of the difficulty lies in a systematic arrangement of the two subjects in a single textbook.

There is much to be said in favor of this plan and some of the advantages are enumerated in the following.

It facilitates a psychological arrangement of the subject matter. Each of the various divisions of secondary mathematics—arithmetic, algebra, geometry, and trigonometry—includes simple principles relatively easy to master, and also difficult, complex principles. The simple principles are best suited to beginners, and may therefore be brought together in a course which gradually leads up to the more complex aspects of these various branches of mathematical science. Each subject is reinforced by the aid of the others, and the entire work is unified and vitalized. For example, algebra and geometry supplement each other. Both are used to express facts about quantity. The formula and the graph are only different ways of expressing the law of a group of numerical facts. Each states the facts in generalized form and thus makes possible the deduction of any number of particular cases. Moreover, when the two forms of thought are correlated in a single course of instruction the student's comprehension of quantity is at the same time deepened and simplified, deepened because of the more enduring impression made upon the mind, and simplified because the double method of attack makes it easier to overcome difficulties by supplying always a strategic alternative.

It reduces formalism. When the various mathematical subjects are treated separately, each tends to take on the rigid form of the final science. This leads inevitably to a certain formalism in the mode of presentation. Such formalism is not the best method for the high-school pupil. Correlation helps to avoid excessive formalism. Rigor need not be carried beyond the understanding of the pupil.

To illustrate, let us consider the topic of similar figures in demonstrative geometry. Ordinarily similar polygons are first

defined and this definition is then immediately used in the rigorous proof of certain theorems on similar triangles. When geometry and algebra are correlated similar triangles may be first used to furnish some concrete material for a certain type of algebraic work such as solving equations. For this purpose a scientific definition is not needed. It is quite sufficient to speak of similar triangles as triangles having the same shape. Later the pupil discovers by actual measurement that these triangles have equal corresponding angles, and that the corresponding sides are in proportion. He recognizes therefore that there is a valid reason for defining similar polygons as figures having equal corresponding angles and proportional corresponding sides, and that such a definition is rational as well as convenient and practical in the solution of problems and in the proof of theorems.

Ample time is allowed for the development of mathematical abilities. Frequently lack of experience results in inability on the part of the pupil. For example, many girls and boys are unable to appreciate demonstrative geometry because too little time is allowed for experiences that will lead to an understanding of the meaning of a geometrical proof. Some textbooks attempt to develop the ability in a few pages, with the result that the pupil in a few days after the beginning of a course in geometry finds himself deeply involved in a study which is difficult even for the adult. He is called upon to work with a number of geometrical concepts that are not all clear to him. Thus he thinks of a triangle when the theorem states angle. A rectangle represents to his mind a general quadrilateral. The term perpendicular means to him vertical. He sees no difference between a straight angle and a straight line.

The demand to use these and other concepts in a demonstrative proof which as yet has little or no meaning to him offers a second difficulty. Moreover, the whole study seems to him to lack real purpose, because the facts to be established are all such as he would readily grant without proof. He soon finds himself imitating or memorizing mechanically work which he does not understand. Many pupils are groping in the dark for months trying to get into the spirit of geometry. The pupil should meet these difficulties gradually, not all at one time. This is easily arranged where the mathematical subjects are correlated.

Thus in the first year the pupil may get much experience with the new geometrical concepts. Strong emphasis is to be placed

upon intuition, observation, description, and motor control. At first students should be taught to measure, to construct with ruler and compass, to recognize the fundamental forms of geometry in the classroom and elsewhere. This suggests many geometric truths. Concepts and facts discussed are to be expressed first in terms already familiar to the student, then gradually translated into the precise language of geometry. For example, he learns that similar triangles are triangles having the same shape. The exact definition is given later. The fact that measurements are at best only approximate, and are very tedious and difficult if carefully done, gradually leads to a desire for better methods and to a need for the logical method. In short, these experiences motivate the logical procedure. Toward the end of the year the pupil begins to establish facts by informal reasoning. The method of proof is to be always informal, its aim being to establish geometric facts and to prepare for, not to develop skill in, logical demonstration. Attempts at lengthy formal demonstration are to be made later.

The following example illustrates the method. It is required to find the sum of the angles of a triangle.

First method: Draw a triangle. Tear off the corners and place the angles adjacent to each other as in the figure below. What seems to be the sum of the angles of the triangle?

Later in the course when learning the use of the protractor this fact is established again as follows:

Draw a triangle. Fill out the table below with reference to this triangle.

Angle	Classify angle (Acute, Obtuse, etc.)	Amount of Rotation (Complete, Half, Less than Half, etc.)	No. of Degrees (estimated)	No. of Degrees (measured)	Error
a b c					
Sum					

The last method is the logical proof. Using the following figure in which DE is parallel to AC, prove that the sum of

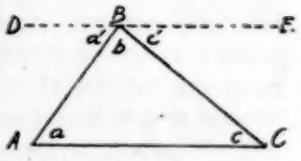
the interior angles of a triangle is two right angles.

Proof:

$a'+b+c' = 180.$ Why?
$a' = a.$ Why?
$c' = c.$ Why?

Therefore,

$a+b+c = 180.$ Why?



If a class is far enough along to understand a formal demonstrative proof, such work may be done in the second half of the first-year course, but rigor should never be carried to the point where the class is unable to appreciate it. The second year is the time to give extensive training in demonstrative geometry.

Similarly, in algebra, certain processes which logically belong together but represent real difficulty for the beginner may be separated in treatment. Thus the pupil should first become thoroughly familiar with unsigned literal numbers and with operations and laws of such numbers. Later he may review these operations and at the same time study positive and negative numbers, the laws of signs, and the operations with positive and negative numbers.

Correlation makes it possible to fit the subject more effectively to the needs of the pupil. Since both algebra and geometry contribute to the intellectual life correlation will make these subjects more productive for mental life and growth. The student who expects to take only one year of mathematics in the high school will acquire a knowledge of such geometric facts as he is most likely to make use of in later life; he will know enough algebra to prefer the algebraic method of solving problems to the less effective arithmetic method. He will receive training in both plane and solid geometry. Many theorems of solid geometry closely related to corresponding theorems in plane geometry should be taught in the second year, thus training the student in both two- and three-dimensional thinking.

The fundamental notions of trigonometry, usually kept from the student until the third or fourth year of high school, will appeal to him because of their usefulness as tools in problem solving. Hence these notions should be introduced at an early stage and so presented as to create no material difficulty for the beginner.

Correlation satisfies the demand for concrete mathematics. There is a real need for making concrete the abstract processes of algebra. No one teaching a course in calculus would think of de-

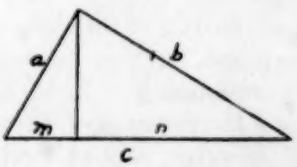
fining a fundamental concept like $f'(x)$ without concrete background. Likewise, the simple elementary concepts of algebra must be made concrete. This can readily be done by the early introduction of geometry which may be used as an aid in making clear algebraic principles and processes, and which furnishes to the pupil of high school age an abundance of concrete material. Not only is space available for use in geometry, but it is the *most available* material. For example, the symbols a, b, c may represent the lengths of the sides of a triangle, $a+b+c$ the perimeter, $a.b$ the area. The equation $a+b+c = 180$ may represent a relation between the angles of a triangle, and $a^2+b^2 = c^2$ a relation between the sides. Abstract processes of algebra can be made concrete, and important relations such as $(a+b)^2 = a^2+2ab+b^2$, and $(m+n)(c+d) = mc+nc+md+nd$ may be interpreted geometrically. The graph is used to illustrate the fundamental processes and to make clear the steps in the solution of equations. Thus the pupil is in less danger of juggling symbols without insight into the real meaning.

Needless reviews are avoided. Through the employment of algebraic notation and the continued application of the equation to geometrical matters firm hold is kept on algebra. The equation $x = y$ may express the fact that two lines are perpendicular; $x+y = 90$ means that two angles are complementary; AB = BC means that triangle ABC is isosceles. Many geometric facts are easily stated in algebraic form and many proofs are simplified by using algebraic notation.

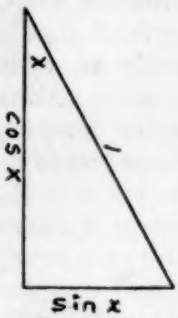
For example, the proof of the theorem of Pythagoras which is one of the longest proofs in plane geometry and of considerable difficulty, assumes the following simple form with the use of algebraic notation:

Proof:

$$m/a = a/c$$
$$n/b = b/c$$
$$a^2 = mc$$
$$b^2 = nc$$
$$\therefore a^2+b^2 = (m+n)c = c^2.$$



This constant use of algebra makes unnecessary long reviews of the first course such as are found in "second courses" in algebra, or at the beginning of a course in college algebra. The frequent use of theorems in furnishing principles for stating algebraic equations gives opportunity not only to review those theorems but also the proof.



Moreover, knowledge gained in algebra and in trigonometry is easy to recall when made concrete by geometry. For example, the triangle in the adjacent diagram establishes such relations as $\sin^2 x+\cos^2 x = 1$, $\tan x = \sin x/\cos x$, $\sec x = 1/\cos x$, and co-sec $x = 1/\sin x$. It also illustrates the changes in the sine and cosine functions as x is made to vary. By keeping this drawing in mind the pupil will easily recall these equations when they are needed.

Correlation furnishes motives for better methods and further study. The student sees the advantages of having various modes of treating the facts of quantity. The graph will bring out facts which are not easily detected from a study of a table; while the equation will give all these facts in a brief form which will readily yield a particular required fact.

For example, a table showing the consumption of electricity for each month during the twelve months of a year does not readily reveal certain facts which are easily detected by looking at a graph representing the data of the table. The graph not only gives these data but gives additional information. It shows that more electricity is used during some months than during others, that there is a gradual increase from month to month which is followed by a similar decrease. It leads the observer to inquire into the causes for these changes. It may even be possible to tell in advance what the approximate consumption is going to be for a certain month not designated in the graph. Similarly, a trigonometric table does not readily give any information regarding the changes of the sine function as the angle changes from 0° to 360°, while the graph pictures these changes very clearly. Moreover, the equation does not only give all the data of the table and those represented approximately in the graph, but may be used to give additional data. The graph of the equation $y = 3x+5$ may furnish corresponding values of x and y for values of x between -10 and $+10$. The equation itself, however, may be used to find values of y for any assigned value of x.

The superiority of algebraic over geometric or arithmetic methods is used as a motive for the study of algebra. Trigonometric methods, used to replace those of algebra and geometry, give opportunity to show the value of trigonometry and its advantages over algebra and geometry. Thus the student's

interest in subsequent studies is aroused and he is more likely to continue the study of mathematics.

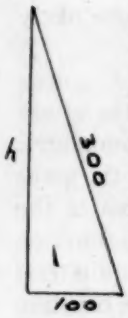
Functional relations are emphasized throughout the course. These fundamental concepts are taught not only in the study of algebraic polynomials or in connection with trigonometric ratios, but also in the study of geometric figures. Thus, the areas of polygons are functions of given dimensions; the area of the circle is a function of the radius; the area of a triangle is a function of two sides and the included angle; the area of an equilateral triangle is a function of the side; the side of a triangle is a function of the opposite angle; an inscribed angle is a function of the intercepted arc. In this manner functional correspondence and functional thinking are constantly being emphasized.

The question will be asked whether the results attained by a course in correlated mathematics are superior to those of the traditional courses.

There is an increased interest and enthusiasm on the part of the pupils which come with better understanding. Pupils may have difficulties but they never get lost so completely that they are not able to profit by instruction during the remainder of the course, as ability in one subject inculcates confidence in the other. In a standardized test which recently was given to all freshmen in the University of Chicago High School it was found that not only did they make a good showing in the work they had had, but that they did not hesitate to do types of work they had not studied in class. Several pupils succeeded in solving a system of simultaneous equations although that topic had not yet been taken up in class.

One of the best results, however, is the ability of pupils to apply mathematics in other high-school studies, such as physics, and in the more advanced mathematical courses such as college algebra and analytic geometry. Complaints which used to come frequently from the teachers of physics, when the traditional courses were given in the University High School, have entirely ceased.

There is a gain in mathematical power. When they make the acquaintance of only one subject in mathematics during the first year, many students fail to get an insight into secondary mathematics. Discouraged by failure in one subject, these pupils do not continue the study of mathematics, and thus they miss the opportunity to discover that they can be successful in another subject. However, in an introductory course in which



algebra and geometry are taught together, pupils soon learn to attack problems by various methods. A problem in indirect measurement, such as finding the height of a flag pole h, in the adjacent figure, may be worked geometrically by means of a scale drawing, or algebraically by solving the equation $h^2+100^2 = 300^2$, or trigonometrically by means of the formula $h = 100 \tan A$.

The ability to use various methods of attack and the experience of meeting problems in a large number of situations gives an excellent preparation for future college work. The reason why so many college teachers complain that high school pupils do not master the fundamentals of high-school mathematics lies mainly in the limited field of application. A pupil may master the solution of a quadratic equation with excellent results and be at a loss how to solve the equation $2\sin^2 x+3\sin x+1 = 0$. By correlating algebra, geometry, and trigonometry the pupil meets the fundamentals of high-school mathematics in a large number of situations.

This increase in mathematical power also results in a decrease in the number of failures.

One more important result of correlation is the saving of time. A representative high school class will cover in three years the work which in separate courses is usually given in one and one-half years of algebra, one and one-half year of geometry, and one-half year of trigonometry, or a total of three and one-half years. This has been accomplished in the University of Chicago High School for several years, as well as in a number of other schools, where the courses are correlated. The saving is not effected at a loss to the pupil, but is the result of a better arrangement, clearer understanding, and of time gained by making frequent reviews unnecessary.

PLATINUM FROM ALASKA.

The output of platinum, palladium, and other metals of the platinum group in Alaska in 1918 is estimated at 284 fine ounces, valued at $36,600, according to the U. S. Geological Survey, Department of the Interior.

Platinum was recovered from the gold placers of some districts in larger amounts and from some in smaller amounts than last year.

One of the most interesting events of the year in connection with Alaska mining is the recovery of substantial amounts of palladium and of some platinum from the copper ore of the Salt Chuck mine, near Ketchikan.

SUCH IS LIFE.

By ELEANOR J. OLMSTEAD,

High School, Antigo, Wis.

"Boy Wanted." The sign loomed huge and compelling before the door of Mr. Penner's grocery store. Mr. Penner showed rare judgment in putting it there just before the schools were out for all of the high-school boys stopped before his door on their way home from school.

"Say, fellows, there's my chance," yelled Sam Harris as he left them and burst into the store. "Mr. Penner, I'm your boy. What'll you give me? I'm some classy kid, all right—I ought to come high."

"Yes," drawled Mr. Penner, "the likes of you come altogether too high for me. Get out!"

And out Sam got. He felt a little chagrined but the bunch soon had him lively again and they raced off to the skating pond.

Jim Moffat came along after them and he too stopped in front of the store. Now Jim wasn't like Sam, not one bit, but he was a regular fellow just the same. He didn't have much money so the chance of a job appealed to him. It didn't make any difference to the boys whether Jim had money or not. He had the punch and pep which made him popular and which made the boys elect him class president and captain of the basket-ball team and a host of other things too numerous to mention. But still Jim kept going in the class room and when he took home his report card it was with no sense of depression but rather of elation because he knew that he had made good in a way that the home folks would appreciate. Oh, yes, as I said, Jim was a real fellow even if his kind were rare. And I forgot another thing—the girls liked Jim as well as the boys did. But don't think he was a sissy; girls don t like that kind. They liked him because he was big and clean and good fun and square in everything.

But to go back to our story. Jim was on his way home and he, too, saw the sign, "Boy Wanted." Before he had had time to think about it he went into the store and said,

"Mr. Penner, you want a boy. I want a job and I ll do the best I can to keep one. Will you take me?

Mr. Penner was delighted with Jim as people always were and engaged him on the spot and told him to come to work on the next day which was Saturday when Jim could work all day.

Jim was at the store bright and early and ready to begin work.

He swept out the store, he arranged the windows, he waited on customers, he did all sorts of things. At one time there was a lull in the number of people who came to get the sugar for Sunday's cake or the Sapolio for Saturday's scrubbing and Jim looked over to see Mr. Penner standing dubiously before two big—boxes of tea.

"Anything I can help you with, Mr. Penner? he asked.

"Wal, now, I don't know," drawled Mr. Penner, "but I don't no-hows think so. Ya see I'm in a fix, sorta. I got these here two boxes of tea and they are two different prices. But the folks what come in here want one price for their tea er else they's continually arskin' me what's the difference. So I'm aimin' ta sell it at one price. Now I want 120 pounds ta fill that there case of mine and I aim to sell it at 80 cents a pound. Now this here box costs 90 cents a pound and that there costs 60 cents. Now how much of each shall I take ta get my 120 pounds and sell it at 80 cents per an' not get cheated and not cheat the other fella?"

Jim's face beamed all over.

"Why, I can tell you how to do that," he said. "We learned to do that at school. Look here." He took a stub of a pencil from his pocket and, tearing off a piece of wrapping paper, started in.

"Now then, suppose we let x = the number of pounds of 60 cent tea you will take."

"That's enough, boy, that's enough," interrupted Mr. Penner. "I ain't got no patience with that there x and y stuff. It's all right in its place, is that there book-larnin stuff, but its place is in the school room, not in real business, see?"

"But, Mr. Penner, —"

"But me no buts, boy. It ain't no use."

"Just give me a chance to show you this much. I know I can find out what you want to know and it is much easier than if you tried to find out by weighing or figuring.

"Let x = the number of pounds of tea at 60 cents per pound.

"Then you want 120 pounds altogether, so $120-x$ = the number of pounds of tea at 90 cents per pound.

"Now, the value of the x pounds will be $60x$ since it costs 60 cents per pound and the value of the $(120-x)$ pounds will be $90(120-x)$ because it costs 90 cents per pound. Altogether the value of the mixture will be $60x+90(120-x)$. Now you want to sell this 120 pounds at 80 cents a pound so the value will be

120 times 80 cents or $96. But this is the value of the mixture. Now let's make an equation and solve it."

$$60x+90(120-x) = 9{,}600$$
$$60x+10{,}800-90x = 9{,}600$$
$$-30x = -1{,}200$$
$$x = 40.$$

"You need 40 pounds of 60 cent tea and 120−40 or 80 pounds of 90 cent tea. Then your 40 pounds will be worth 40×60 or $24 and your 80 pounds will be worth 80×90 or $72. Altogether they will be worth $96, the value of 120 pounds of tea at 80 cents per pound."

"Wal, wal," said Mr. Penner, "I swan. Can you do everything like that? By George, I'll raise you a dollar a day. Bring along your x and y if they can measure my tea for me. War did you larn ta do it?"

"Oh, that's just algebra," laughed Jim. "That's easy stuff but it does come in handy sometimes."

The day was soon over and Jim, with his extra dollar earned by his algebra, went home to sleep a tired sleep.

Now every real story must have a girl in it and since this is a real story I'll tell you about the girl. Her name was Ethel and she and Jim had lived next door to each other since they were babies, had graduated from the same grade school, and now were going to the same high school. Sunday afternoon when Jim came out on his front porch he saw Ethel going into her house and apparently thinking very intently about something.

"Hi there," he called across to her, "a penny for your thoughts. What's the matter?"

"Oh, Jim," said Ethel, "please come over and help me figure something out. I'm in a terrible mixup."

Jim was there in two bounds. "Now what's the matter?" he demanded, as they went into the house together.

"Well, you see it's this way. I'm treasurer of our Sunday school class and when we gave that play last week we decided to divide the proceeds. They amounted to $93 and there are seven of us. But Mary Dortman spent so much more time on it than any of the rest of us that we think she should receive five dollars more than any one else gets. I've tried figuring it every way and I always get balled up."

"Well, now," said Jim condescendingly, "there's where your algebra should come in. Just see here:

Let x = the amount for each of you.

But Mary gets \$5 more so she gets $x+5$.

There are six who get x dollars so that amount is $6x$.

Altogether you have \$93.

Then $6x+x+5 = 93$

$7x = 93-5$

$x =$ \$12.57, which is what each of you get

Mary gets \$17.57. Then you will have 1 cent left over since it doesn't come out even which I move you give to me for figuring it out for you."

"You're a brick, Jim," exclaimed Ethel. "I wish I could remember my algebra as well as you remember yours."

Now of course I don't claim that the algebra did it. It may have been mere propinquity but when the years had passed and Jim and Ethel decided to start housekeeping by themselves their friends laughed because they said that Jim must have worked out a proposal by algebra and that Ethel had had to agree because it was so logical. At any rate they had a great time preparing for the wedding even if folks did ask them if they intended to have the church aisles marked off in "x's" and "y's."

One day when Ethel was looking through her cake recipes trying to decide on the right one for the bridal cake she hit upon a very original plan and she immediately called up Jim to tell him about it. He came right over and they sat down to figure it out.

"You see," said Ethel, "I thought that I should like to include a recipe for my bridal cake in the box of wedding cake I am going to have for each guest. Usually if a recipe is to be made for more people it is just doubled or tripled as the case may be Wouldn't it be a good joke to write the recipe to include x so that the number of cakes could be substituted and the recipe hold good at all times?"

"It would be great fun," said Jim. "Why not do it like this? Write out your recipe for one cake and then add x to each part; for instance:

$2x$ cups of sugar,

$1\frac{1}{2}x$ tablespoonsful of butter,

$6x$ eggs, etc. Then add a note which will say to substitute for x the number of cakes wanted. Then no one would ever make a mistake and forget to double or triple any part of the recipe."

Ethel did as Jim had suggested and her algebraic cake recipe became the talk of the town.

After the wedding festivities were over and Jim and Ethel had

settled down in their own home, Ethel said one night, "Jim, I've decided to be very systematic in our household expenses. I'm going to decide just how much we should spend for food, for clothes, for amusements, and so forth, and then find out each month how closely we come to what I've decided on. I wish I could think of some plan of showing it better than just by figures."

"Well, how would this do," suggested Jim, "we'll make graphs just as we used to do in our algebra class. We'll make one graph which will show the ideal expenditures and then each month we'll make one for that month and as it goes above or below the ideal one so will our expenses go."

"That's a great idea," said Ethel, as she came and perched on the arm of Jim's chair. "Do you know, Jim, I've decided something. After all, no matter how unimportant what you learn in high school seems at the time there is always a use for it later on if you try to find that use. And that's true even for algebra."

"Yes, Ethel, I think you're right," answered Jim. "There's nothing in the world so hard or so disagreeable but what we find a use for it some time if we want to."

WEST INDIAN SURVEYS.

An increased appreciation of the value of scientific investigation in planning the wise utilization of natural resources has led several of the West Indian republics to seek the assistance of the United States Geological Survey, Department of the Interior, and to make cooperative agreements with it, whereby topographic and geologic surveys of the islands are to be made at the expense of their governments and the technical supervision of the work is to be assumed by the Geological Survey. The officials of these republics welcome this method of assuring the same quality of mapping for their areas as is obtained in surveys of the United States, and this appreciation of the aid thus given should lead to a larger American participation in the industrial and commercial development that ought to follow this inventory of mineral and land resources.

At the end of the fiscal year a general geologic reconnaissance had been made in the Dominican Republic, and arrangements had been completed for organizing the topographic surveys, field work to begin early in September. In the Republic of Haiti plans were perfected for similar work.

In a special message to the Cuban Congress the President of Cuba has urged an appropriation for the topographic and geologic survey of the island. The cooperative assistance of the Geological Survey has been promised by the Secretary of the Interior to a representative of the Cuban Government as well as in official correspondence, and it is expected that this largest of the West Indian projects will be begun within a year.

A geologic reconnaissance of the Virgin Islands of the United States and a part of Porto Rico with particular reference to ground-water resources was made in May and June. In Porto Rico a topographic survey also is desired by the local government.—Annual Report of Director, United States Geological Survey.

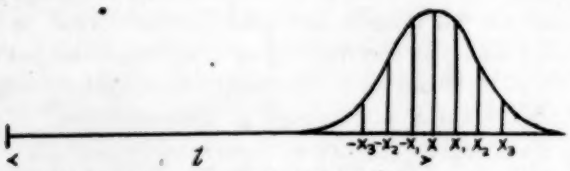
WEIGHTING OF DATA.

By J. P. BALLANTINE,
University of Maine, Orono, Maine.

The purpose of this paper is to suggest a method of weighting data, assuming that all the measurements are taken with equal care and are equally reliable.

Suppose one were measuring a quantity whose true value is l. The results are m_1, m_2, m_3, etc.; the errors are x_1, x_2 . . . etc.

Corresponding to x_1, x_2 . . . etc. erect ordinates. In the ideal case, when there is a large number of such ordinates their distribution will be denser near the small errors, and will gradually become less dense on either side. In fact, if the curve $y = Ke^{-h^2x^2}$ be plotted, these ordinates will cut off equal areas under it.



This condition will never be fulfilled in practice. Let us assume, however, that if there are n errors, x_1, x_2 . . . etc., and if we artificially cut the area under the curve $y = Ke^{-h^2x^2}$ into n equal areas by $(n-1)$ suitably chosen ordinates, that each x will fall in a different area.

Consider the various equal area enclosures as cages, and a particular variable x as a tiger walking to and fro, but kept in his cage by the above assumption. What effect will the corresponding change in m have on the average l?

Let w_1 be the weight of the m_1 concerned, and w be the total weight of all the other m's.

Let d_1 be the frontage of the cage.

Then

$$l_1 = \frac{m_1w_1+mw}{w_1+w}$$

$$l_2 = \frac{(m_1+d_1)w_1+mw}{w_1+w}$$

$$\therefore l_2 - l_1 = \frac{d_1w_1}{w_1+w} = \triangle_1 l$$

$\triangle 1$ is the effect on the weighted average l, of each journey of the tiger.

In reality, in place of one tiger, there are n tigers swaying back and forth according to their limited means, and with individual periods. The 'Keeper' would probably put the heavier animals in the center where their courses are shorter, and the lighter wild cats, etc., out further where their courses were longer.

In the same way, we would give a larger weight to the m with a smaller error x, in such a way as to make wd the same for all the n measurements.

$$w_1 = c/d_1 = cy.$$

Therefore, weights should be proportional to y.

A simple way of choosing weights proportional to y is to take coefficients of the binomial expansion $(1+1)^{n-1}$

Rule. Given n measurements of a quantity, arrange them in order of magnitude, and give them weights corresponding to the coefficients of the binomial theorem.

Note. As further evidence of the need for light weighting the largest and smallest m, elaborate methods have been devised for rejecting, i. e., assigning weight zero to the smallest or largest reading.

A PLEA FOR HIGHER SALARIES FOR TEACHERS.

Pointing out that an adequate wage for Illinois' 34,000 school teachers is the safest insurance for the future, a committee of 1,300 Chicago teachers have launched their drive to that end. They are devoting a half day's pay to further their cause.

A review of their share in the war is one of the arguments advanced by the teachers, who point out that their minimum wage request—$1,000 a year— is less than the sum earned by the humblest laborer.

Citing expressions from military men to prove that the Nation's triumphs in arms were due in large measure to the patriotism inculcated in the schools, the teachers point out that the teaching of American ideals must not be intrusted to teachers who are underpaid and thus tempted to instruct in radicalism prompted by a deep sense of personal wrong.

Radicals and anarchists are fully awake to the thriving field the groups of underpaid teachers offer, as the Chicago teachers have already been solicited three times this year by the I. W. W. and radicals of kindred doctrines.

"The duties of the schools now and for the future are the most important in their history," says a statement issued by the teachers, under direction of William T. McCoy. "The experiences of the war show that pro-German propaganda thrived where the American school had been neglected; that the large percentage of illiteracy was found only where vigilance in education had been relaxed.

"To correct that, more education is imperative. But teachers are finding the increased cost of living their chief difficulty, and despite years of sacrifice and preparation are being forced to quit.

"This must not be. The seriousness of the situation must be apparent to everyone."

THE DIFFERENTIAL PULLEY OR CHAIN HOIST.

By W. F. Roecker,

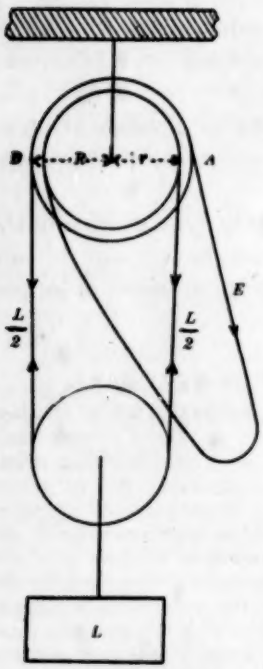
Boys' Technical High School, Milwaukee, Wis.

1. Diagram and describe the construction.

(a) Why call it differential?

(b) How is it like ordinary pulleys? How different?

2. The velocity ratio is a measure of the mechanical advantage.



(a) Show that $\frac{L}{E} = \frac{2R}{R-r}$.

(b) How would you construct a differential pulley with a high mechanical advantage?

(c) Find the M. A. if R = 10″ and $r = 8''$.

3. Input × Efficiency = Output.

(a) How is the input determined? The output?

(b) Define efficiency. How is it determined?

(c) What is the average efficiency of differential pulleys? Why is it so low?

(d) Why are sprocket wheels used?

4. Find the mechanical advantage and efficiency of a commercial differential pulley.

(a) Measure R and r and solve according to formula above.

(b) Measure D (effort distance) and d (load distance) and check against (a).

(c) Determine the force required to lift a member of the class; also determine the friction overcome.

(d) Calculate input, output and efficiency. Consider a lift of 5 feet.

5. Does the efficiency depend upon the load?

(a) Find the efficiency of this pulley in lifting a chair.

(b) How does this efficiency compare with that in (4)?

(c) Why is the efficiency not constant for small loads?

(d) How would you expect the efficiency to vary for larger loads, such as occur in actual service? See Ref. (b).

(e) What makes the load self-sustaining?

6. Calculate what force will be necessary to lift a member of your class whose weight is known. Check it by actually lifting him.

7. Problem. If it requires a force of 500 pounds to lift the front end of an automobile, how great a force must be exerted on the chain of this pulley to raise the automobile, if the efficiency is 30 per cent under this load?

8. What distinct advantages does the differential hoist offer?

REFERENCES.

(a) *Practical Physics*, Black and Davis, p. 30-31.
(b) *Elementary Practical Mechanics*, Jameson, p. 228-232.
(c) *Introductory Mechanics*, Bedford, p. 57-59.
(d) *Shop Arithmetic*, Norris and Smith, p. 126-128.
(e) *Encyclopedia Britannica.*

"THE HOLY LAND."

BY F. RENWICK.

How many visitors wintering in sunny Egypt have cast longing eyes towards the Holy Land but were afraid to embark on the short sea journey because of the uncertainty of landing at Jaffa! Now, they will be able to make the pilgrimage by rail all the way from Cairo to Jerusalem passing through a country of great biblical interest. Assuming the journey be made in the springtime, it will be especially delightful as the Plains of Philistia and Sharon are then carpeted with flowers. What a contrast to the sandy desert of Sinai first crossed!

Palestine still retains its unique attractions, both sentimental and otherwise. The traveler can now visit the various places of interest under conditions which never existed before.

Jerusalem, the capital, has a fine situation standing on four hills once divided by deep valleys which are now partially filled by the debris of successive destructions of the city. It did not suffer by bombardment in the recent campaign. Its ancient walls and picturesque buildings are just as before. Since the British occupation a number of improvements, mostly sanitary, have taken place and there is a feeling of security never enjoyed under Turkish rule. No longer is there any danger of falling among thieves on the way to Jericho. A dip in the Dead Sea (1,300 feet below sea level) or a swim in the River Jordan may be indulged in, with the certainty of finding one's clothes on the bank when required. The Church of the Holy Sepulchre can be visited, not once but several times, with pleasure and profit, there are many corners to explore and one just wanders around at will. The Mosque of Omar, standing on the site of Solomon's Temple, formerly only accessible to visitors escorted by a Turkish soldier and a consular canvass, can now be entered and all its details inspected at leisure while the dragoman points out anything of special interest.

The railway has been constructed from Ludd (Lydda) to Haifa. It is quite an interesting ride from Jerusalem to Haifa mainly along the Plain of Sharon. Just before reaching Haifa there is a good view of Athlit, the last stronghold of the Templars in Palestine and particularly interesting in view of the late war and re-conquest of the country by the crusaders of modern times.

A NEW METHOD OF RATING TUNING FORKS.

By W. H. Farr,
Laboratory of the Central Scientific Company, 460 East Ohio Street, Chicago, Ill.

When imports of scientific material were cut off by the European War, one problem presented to this laboratory was the rating of tuning forks, as the Central Scientific Co. soon undertook their manufacture on a large scale. Needless to say, standards were immediately provided for the pitches in most common use so that such forks could be tuned by direct comparison with a standard, but it was often required to rate small quantities of forks of unusual vibration numbers. For some time the method used was that of making tracings on a smoked drum, the time being determined by means of a seconds pendulum and a time marker. Altho the results were sufficiently accurate, the method was rather tedious for commercial testing where time is an important factor. With a view to overcoming this difficulty, we undertook to investigate the applicability of the stroboscopic method of the measurement of pitch, as developed by Dr. E. Seashore of the State University of Iowa in his "Tonoscope."[1]

The essential features of the Tonoscope are a revolving screen or drum, a synchronous motor for driving the drum at a constant speed, and a manometric flame device. On the surface of this drum are parallel rows of dots, each row containing a different number. The number of dots in each row corresponds to a certain pitch, there being sufficient rows to represent a complete octave. The drum is revolved at a speed of exactly one revolution per second. A tone is sounded in the mouthpiece of the manometric flame apparatus, producing a flickering flame, and the revolving drum is observed by the light of this flame. The row of dots which has the same frequency as this tone appears to stand still while all the other rows are apparently moving in one direction or the other. By means of a scale properly placed and numbered, the pitch of the tone is read off directly.

A modified form of this device was developed by Dr. L. E. Dodd while a graduate student at the State University of Iowa. In this form a small cylinder is used, being rotated by a phonograph motor of the Edison type. The sound whose pitch is to be measured is directed against a diaphragm, on the back of which is mounted a mirror. A beam of light from a lamp mounted

[1] *Science, Vol. XLIII*, No. 1113, April 28, 1916, page 592.
Electrical Experimenter, Vol. IV, No. 5, September, 1916, page 320.

behind the mirror is thrown on the rotating cylinder and the flickering of this beam of light by the vibration of the diaphragm gives the strobosopic effect described above.

When an attempt was made to adapt one of the above forms of apparatus to the problem of rating tuning forks, the following difficulties were encountered. The Seashore type is much larger than would be necessary for this work, the synchronous motor and its controlling mechanism is somewhat complicated, and the facilities at hand were not adapted to the graduating of a cylindrical surface. Also it requires that the sound be projected against a diaphragm, which is not readily done with a tuning fork. The Dodd type is much more compact and its mechanism simpler, and has the advantage of using a commercial type of motor. However, it presents the same problem of graduating a cylindrical surface, and also requires the sound to be projected against a diaphragm. Furthermore, as in both the above types a rather faint source of light is used, it is necessary to either darken the room or provide some kind of shade for the scale.

In the form which was finally developed in this laboratory a flat disk is used as a revolving "screen", it being rotated by means of any ordinary phonograph motor. The placing of the rows of dots on this disc was not difficult, as it was done in the circular dividing engine. The disc is 10 inches in diameter, having white dots on a black background. There are 34 concentric rows (or rings) of dots, containing every even number from 62 on the inner row to 130 on the outer row, giving a little over a complete octave. This is carried on the turntable of the phonograph motor, a scale being provided directly above it which indicates the number of dots in each row. The speed of the motor is controlled by means of the usual friction governor.

The first job on which this device was used was tuning some special forks of 117 and 127 v. p. s. which had screens or shutters on the end of the prongs. These shutters were provided with slits so arranged as to alternately open and close with each vibration of the fork. When the rotating disk is observed thru this slit, the stroboscopic effect described above is easily seen.

During the course of the above work the discovery was made that it was possible to rate a fork without having it provided with shutters. The fork is set in vibration and held so close to the eye that the edge of the prong almost obstructs the vision. In this position the prong of the fork swings in front of the eye at every vibration, giving an effect very similar to that of opening and closing a shutter.

This discovery increases the usefulness of this method considerably, as it makes it possible to rate any kind of fork without any alterations or attachments.

The procedure in rating an unknown fork is as follows: The disk is set in rotation and the speed is adjusted to one revolution per second by comparison with a standard 128 V. P. S. fork. The unknown fork is then set in vibration and held to the eye, and the vibration rate is read on the scale. Altho the rows on the disk contain only even numbers of dots, there is no difficulty in reading odd vibration numbers. In this case, no row of dots will stand still, but there will be found two adjacent rows in which the dots are moving in opposite directions at the same speed, indicating that the correct reading would lie just half way between. When the reading lies between two figures on the scale, it is possible by estimating the relative speed of the rows on either side to estimate the rate of the fork to within one half V. P. S. It is also possible to rate a fork whose tone is an octave above or below that represented by the numbers on the scale. The readings are taken in the same way and at the same disk speed, but in the first case one apparently sees twice the actual number of dots and in the second case half the actual number. If the speed of the disk were doubled, this would extend the range of the instrument at least one octave higher.

The accuracy of this method is limited only by the constancy of the speed of the motor. A spring motor would not be satisfactory for precision work, but is sufficiently constant for commercial testing. The fluctuations in speed occur largely at two points; just after the spring has been wound up, and when it is about run down. Between these two points very little attention is required to keep the speed regulated within the necessary limits of accuracy.

The following are some of the advantages presented by this type of construction.

Owing to the difference in diameters of the various rows it is possible to make the spacing of the dots approximately the same in each row, which is not possible in the case of a cylindrical screen.

If it is desired, a number of disks with different graduations may be prepared and used on the same machine, as they are easily changed as phonograph records.

With this device readings are taken directly, without the use of a manometric flame or vibrating mirror and without any attachments on the fork.

FORMULA FOR GROUP TESTS.

By Harold S. Hulbert, M. D. (*Detroit*),

Past Assistant Surgeon, National Naval Volunteers, U. S. Navy.

Incidental to the giving of group tests, a new formula for relative scoring was necessary. No existing formula was known which met all the requirements, so a new formula was evolved. This formula is $(T+MS)/(M+M^2)\times G$. It is applicable for scoring any group tests where the maximum of work which may be done in each test may be determined and where there are measurable variations in the total work done and in the success of the work done by the individuals tested. The symbols used may be thus explained: M = Maximum, S = Number of Successes, F = Number of Failures or Errors, T = Total, N = Number of tests, G = Grade, and % = Score.

The mathematica' accuracy of the formula depends upon the assumption that of M possible things to do, the perfect score shall be divided into M+1 parts, of which one part shall consist of the attempt without success to do the M things and the M parts shall consist of the M successes. Then an attempt to do one of the M things without success deserves a score of $1/M\times 1/(M+1)\times G$; an attempt to do T things without success deserves $T/M\times 1/(M+1)\times G$; an attempt to do T things with one success deserves $T/M\times 1/(M+1)\times G+1/(M+1)\times G$; and an attempt to do T things with S successes deserves

$$T/M+1/(M+1)\times G+S/(M+1)\times G = (T+MS)/(M^2+M)\times G.$$

The Maximum (M) is the greatest total any one in the group achieved, but after any test has been given and scored a great number of times, e. g. a thousand cases, the Maximum (M) for any test may be empirically set at the highest average, maximum. The Maximum (M) for any one test would not necessarily be the same as the Maximum (M) for another test. Note, in the original work based on one thousand cases and verified by forty-one thousand more cases, M = 75 on the so-called "cancellation test" and M = 50 on the so-called "code test" according to the conditions under which these tests were given.

The Grade (G) is the highest score obtainable on any one test, and is G = 100%/N or 100% divided by the number of group tests, e.g., if but one test is given G = 100%, if two tests are given G = 50.0%, or if three tests are given G = 33.3%. Note, in the original work two group tests were given, therefore G = 50.0%.

The Successes (S), the Failures or Errors (F) and the Total (T) of each individual in each test is noted when the work is corrected. As the Total (T) is the Successes (S) plus the Failures (F), T = S+F, only the Total (T) and the Successes (S)

need be considered in the computations, S and F being reciprocal. Total (T) may vary from 0 to Maximum and Successes (S) may vary from 0 to Maximum (M), but only in a perfect score would Successes (S) equal the Maximum (M).

Knowing the Maximum for any group test, the percentage of the possible Grade (G) for all possible combinations of Successes (S) and Total (T) may be computed and charted for reference. For daily use blue prints of the full chart may be used, cf. outline of chart, Fig. 1.

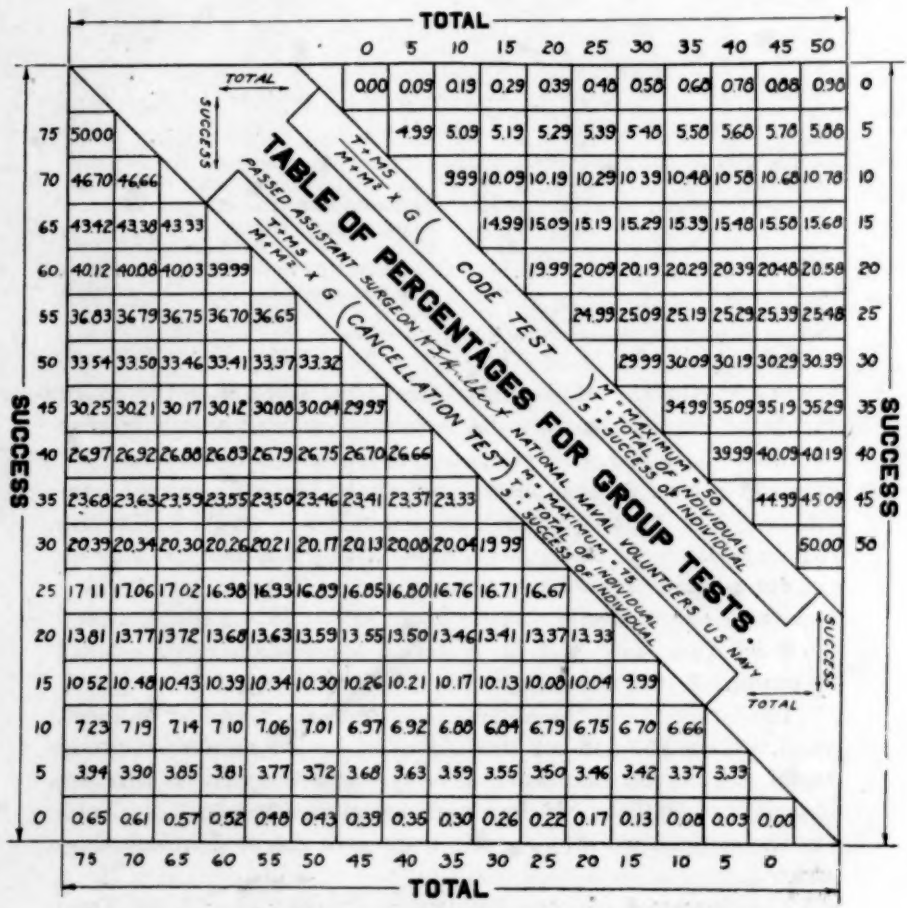

TOTAL
SUCCESS
TABLE OF PERCENTAGES FOR GROUP TESTS.
PASSED ASSISTANT SURGEON U.S. NAVY
NATIONAL NAVAL VOLUNTEERS U.S. NAVY
CODE TEST
CANCELLATION TEST
T = MS / M + M² × G
M = MAXIMUM = 50
T = TOTAL OF INDIVIDUAL
S = SUCCESS OF INDIVIDUAL
M = MAXIMUM = 75
T = TOTAL OF INDIVIDUAL
S = SUCCESS OF INDIVIDUAL

FIG. I.

Outline of chart showing computed values of scores Total (T) and Success (S) as graded by the GROUP TEST FORMULA $[(T+MS)/(M+M^2)] \times G$. For clarity in printing only the value of every fifth number is here charted.

A satisfactory formula for relative scoring of group tests must fulfill the following postulates:

1. The score must range from 0.0% to G or 100%; there must be no minus per cents.

2. Zero per cent must be only for absolute failure, i. e., not only no success, but no attempt or no total.

Example, by this formula, when S = 0, F = 0, T = 0, Score = 0.0%.

3. Without success, with minimum total (one) and with minimum failure (one) some per cent must be given for the effort. S = 0, F = 1, T = 1, Score = 0.01%.

4. With each increase of total but without any success there must be a slight increase in the score, i. e. no success, some failures but the total less than the maximum gives more per cent than the previous example. M = 75, S = 0, F = 37, T = 37, Score = 0.33%.

5. With further increase in the total but without any success is a greater per cent, S = 0, F = 75, T = 75, Score = 0.65%.

6. The minimum number of success must score more than the maximum number of failure, but with slight increase in the score for the increase of the total due to the increase of failures.

Examples:

S = 1, F = 0, T = 1, Score = 0.67%
S = 1, F = 36, T = 37, Score = 0.96%
S = 1, F = 74, T = 75, Score = 1.31%

7. With increasing success there is a rapidly increasing score, and with increasing total due to additional failures there is a slightly increasing score.

Examples:

S = 20, F = 0, T = 20, Score = 13.33%
S = 20, F = 20, T = 40, Score = 13.50%
S = 20, F = 55, T = 75, Score = 13.81%
S = 21, F = 0, T = 21, Score = 14.00%
S = 45, F = 0, T = 45, Score = 30.00%
S = 45, F = 10, T = 55, Score = 30.08%
S = 45, F = 30, T = 75, Score = 36.25%

8. Maximum success is maximum total (75) without any failures equals maximum per cent or Grade (G) which in this series of two group tests is fifty per cent.

S = 75, F = 0, T = 75, Score = 50.00%

Conclusion: By group tests time and effort may be saved. By the formula $(T+MS)/(M+M^2)\times G$ the work of the indi-

viduals tested can be relatively scored and comparisons made, and except for the total failures and the perfect successes the scores of the various individuals will be spread out like the vanes of an opening fan.

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[1] $(T+MS)/(M+M^2)\times G = (T+MS)\times 50/(M^2+M)$. Here all the variables are grouped and multiplied by a constant. Resolving further it equals $[T+(75\times S)]\times 50/(75^2+75) = [T+75S]\times 50/5700 = (T+75S)\times 0.008771$. Therefore when Maximum (M) is 75 and this is one of two group tests (G = 50 per cent) knowing that 0.008771 is the constant, every possible value of T and of S may be computed, e. g.: T = 1, S = 0 or $(1+0)\times$ constant; T = 2, S = 0 or $(2+0)\times$ constant; T = 2, S = 1 or $2+(75\times 1)\times$ constant; T = 2, S = 2 or $[2+(75\times 2)]\times$ constant; T = 3, S = 0 or $(3+0)\times$ constant; T = 3, S = 1 or $[3+(75\times 1)]\times$ constant; T = 3, S = 2 or $[3+(75\times 2)]\times$ constant; T = 3, S = 3 or $[3+(75\times 3)]\times$ constant, etc. In charting, the totals may be the abscissae and the columns vary from 75 to 0, and the successes may be the ordinates and vary from 0 to 75.

Similarly when Maximum (M) is 50 and Grade is 50 (G = 50 per cent) the constant is 0.019607; ordinates and abscissae may be similarly computed and charted.

COST OF BUILDINGS IN 1918.

The United States Geological Survey, Department of the Interior, announces the publication of a report on building operations in the larger cities of the United States in 1918. This report shows the cost of such work in a large number of cities of the country for ten years and contains a diagram showing the great decrease caused by war conditions. It also shows the cost of buildings in these cities by character of buildings—that is, wooden, brick, stone, concrete, or steel skeleton buildings—and the cost of additions, alterations, and repairs, by classes of buildings. A copy of this report may be obtained by applying to the Director, United States Geological Survey, Washington, D. C.

ALASKA PRODUCES 70 MILLION POUNDS OF COPPER.

The copper production of Alaska in 1918 was 69,224,951 pounds, valued at $17,098,563, according to a report on the Alaska mining industry in 1918, just issued by the U. S. Geological Survey, Department of the Interior. This is less than the production in 1917, which was 88,793,400 pounds, valued at $24,240,598. The reduction in output is stated to be due to shortage of labor and ships. During the year seventeen copper mines were operated, the same number as in 1917. A copper prospect on the Alaska Peninsula is under development, and interest still continues, the report states, in the copper deposits of the Talkeetna and Broad Pass districts. The copper deposits in the Alaska Range recently reported are still attracting attention, although little work has been done on them. The deposit of copper discovered in 1915 on Rainy Creek, a tributary of the South Fork of Delta River seven miles above Miller's roadhouse, is said to be a large body of low-grade ore on which considerable crosscutting has been done. There is also a low-grade copper deposit in the gulch one and one-half or two miles west of Paxson's roadhouse. A copper lode on McLaren River, tributary to the Susitna, is said to be ten feet wide and of high grade. It was reported that an outfit was to be taken in on the snow in the winter of 1918-19 to prospect this deposit. A copy of the report may be obtained from the Director of the Geological Survey, Washington, D. C.

WHAT SHOULD THE PHYSICS TEACHER KNOW?

By C. L. VESTAL,

Carl Schurz High School, Chicago.

For generations the answer to a question like this about a teacher would have been: "He must know his subject." In the last two decades something has been happening to this assumption that knowing one's subject is the same as being a good teacher of it. "Knowing the subject" means vastly more today than it meant even ten years ago. Also, another phase has been added to the conception, viz., how the subject bears on actual life. Regardless of the subject taught, the teacher who would today keep the whole-hearted respect of his pupils must be able to at least bring in the atmosphere of actuality. High school pupils do not do much reasoning—wherein they are true to parental example—but they have an instinctive feeling for truth. If the teaching they get does not ring true to the test of life significance, they will have a kind of subconscious contempt for it, and the teacher comes in for his or her share of this contempt. Hence, as I believe, arises a proportion of the disciplinary difficulties and a considerable percentage of the "flunkers." What is the answer? *The teacher must know the bearing of his subject on life itself, and must contrive some natural, matter-of-course way to introduce this bearing into his teaching.* It must not be palpably dragged in by the ears, either, or it will fall flatter than the proverbial pancake. It must sincerely belong.

Applying this test to the subject of physics probably seems easy. The pupil's waking life is pretty largely a series of happenings in Physics. But the mere recognition of this fact is a very different matter from saturating one's teaching with it. You must know a great deal more than your "subject," in the old sense. This chiefly meant having at the end of one's tongue the statement and specialized methods of demonstration of the great physical laws, with especial emphasis upon accurate measurement and abstract calculation. Today, if you expect to be successful in keeping the respect and interest of your classes you must be a kind of general engineer, who is less interested in the formal verification of the laws than in their human uses. You must recognize and apply the great truth that *there is an emotional as well as an intellectual content to the branch of learning known as science.* You must learn to combine science and humanism.

Let me specify a little more closely. First, you must know the physical environment of your pupils in their homes, the shops, the streets, the fields. In approaching any physics topic have in mind this question: "In what way do my pupils make contact with this aspect of physics?" Start your attack with that fact, so far as possible. You must be the beginning of a household engineer, a sanitation engineer, an illuminating engineer, a civil engineer, an electrical engineer, a mechanical engineer, an automobile engineer. You are potentially a steam engine operator, an electrician, a movie operator, a gas engine repair man, a plumber, a glass blower, a machinist, a carpenter, an author, a psychologist, a policeman, a meteorologist, a draughtsman, an inspector.

Perhaps the most vivid way to make this matter seem definite is to state some of the questions that have been asked me, either spontaneously or at my own instigation, during the thirteen years I have been teaching physics. I believe these are questions which the high school physics teacher should for the most part be able to answer. I freely confess that there were many which I could not answer offhand when they were asked, and there are a few of them which I cannot answer offhand now. But they point the way. They show you concretely how the subject touches the lives of your pupils and their parents.

1. What makes "water hammer," and how can it be corrected?
2. Can you give the pupil an easy and simple method of testing out a bell circuit, a method which he can use at home?
3. Can you tell how to get at the magnetic door-latch, to correct its sticking?
4. Can you explain how to read the electric and gas meters?
5. Can you explain how the "central" girl makes the nickel drop down in the telephone box?
6. Can you explain how taking the receiver off the hook signals the operator?
7. Can you explain why the tungsten lamp is more efficient than the carbon filament lamp?
8. Can you explain how the receiver repeats the sound?
9. Can you explain why the nitrogen or argon filled lamps are more efficient than the ordinary tungsten lamps?
10. Can you explain why the candlepower of the lamp gradually diminishes?
11. What makes the faucets "chatter" sometimes? What is the remedy?
12. How can either of two switches turn the light off and on?
13. What are the main features of the Underwriters' code for house-wiring?
14. What are the rules upon which fuses are rated?
15. How are fuses tested for the time element?
16. How can you reverse the ordinary alternating current single phase household induction motor?
17. What is the reason for the soil pipe riser in a house?
18. What sizes of water pipe are allowable in residences?
19. What size is allowable to tap on to the street main from a house?

20. How does the water meter work?
21. How do the gas and electric meters work?
22. What are the relative merits of different types of lamp shades?
23. What lighting intensities should be used in a house, and why?
24. What relation should obtain between window area and floor area in living room lighting and in school room lighting?
25. How does the manufacturer determine the capacity of a furnace?
26. How do thermostats work?
27. What are the relative merits of the different forms of house heating?
28. How are the proper sizes of hot air registers determined?
29. Is sound transmitted much through a wall from room to room?
30. What kinds of walls reflect sound best?
31. What causes some rooms to make it so hard to understand in them?
32. What is the process of piano tuning?
33. Why do people sometimes build their house chimneys higher?
34. How does the interior design of hard coal furnace differ from that of a soft coal furnace, and why?
35. In actual use, are aluminum cooking utensils thermally any more efficient than iron ones? Why, or why not?
36. How do you take a faucet apart to renew worn out Fuller balls?
37. What is the difference in operation between the Fuller faucet and the compression faucet?
38. What are the relative merits of these faucets for household service?
39. Why is the sectional rocking grate for furnaces better than the old type in one piece, and shaking in a horizontal plane?
40. What makes the cuckoo clock "cuckoo?"
41. What are the processes in the manufacture of phonograph records?
42. Why do certain phonograph needles give louder sounds than others, on the same records?
43. Is it true that the phonograph record will not say certain sounds distinctly? If so, why?
44. Why do the piano hammers have felt on them?
45. How does the violinist get harmonics?
46. What makes the colored streaks sometimes seen in window glass?
47. How can you locate by experiment the center of gravity of a chair?
48. On what data are the sizes of furnace hot air pipes determined?
49. How long a nearly horizontal run of such pipe is permissible in residences, and why?
50. Does it pay to cover these hot air pipes with a heat insulator?
51. How much radiator area should be allowed per cubic unit of room?
52. What are the relative merits of the different types of steam heat?
53. Explain in detail the construction and operation of the heating system of the school building?
54. Can you describe the wiring layout of the school building? Of the typical residence?
55. What sizes of wire are required in house wiring?
56. What are the usual permissible sizes of fuses for residences?
57. Why does the wind whistle in the chimney?
58. Why does a high wind affect furnace or stove draught?
59. What causes the "spark" when a switch is opened?
60. Why does a carbon filament lamp light up more slowly than the tungsten filament?
61. Draw a diagram of a residence floor and mark in the best locations for the outlets and switches.
62. What makes an oil lamp smoke?
63. Why is the kitchen range interior designed as it is?
64. How do you adjust gas burners so that they will not "pop back?"
65. What is the service pressure of fuel gas?
66. How is this pressure maintained?
67. What are the causes of the fluctuations in the city water pressure?

68. Why does turning on the electric iron cause the lamps to get dimmer?
69. Why does the listener at the telephone sometimes hear faintly the talk upon other lines?
70. Why does the house plaster crack?
71. Why do dirt streaks come to show along the ceiling parallel to laths?
72. What are the dimensions of the ordinary room door in residences?
73. What is the best pitch for a shingle roof?
74. What is the best location for the kitchen sink, and why?
75. What is the best height for said sink, and why?
76. What is the most efficient positional relation among sink, stove, pantry, and utensil storage?
77. What is the approximate gas consumption of the different sizes of gas stove burners?
78. How can pupils determine this consumption at home?
79. What are the common tread and riser dimensions of the ordinary residence stairway?
80. About what maximum horsepower can the medium sized man exert?
81. How can one test his own horsepower simply?
82. What makes the automobile engine backfire sometimes?
83. What is the principle of carburetor regulation?
84. What is the approximate compression pressure in the automobile engine?
85. What is meant by the "firing order?"
86. Why is the firing order not consecutive from one end of the engine to the other?
87. What causes carbonization in the cylinders?
88. How can carbonization be minimized?
89. Why does the carburetor have an auxiliary air valve?
90. How does the vacuum system work?
91. Does the change in tire pressure due to temperature changes in operation ever endanger a tire in good condition?
92. Why is the cord tire superior to the ordinary fabric tire?
93. Exactly how, in detail, does the ordinary gear shift work?
94. How does the Ford gear-set work?
95. How is the automobile engine lubricated?
96. How does the clutch work?
97. Within about what distance should an automobile whose brakes are in good condition be able to stop on a level road from any one of four or five different and usual speeds?
98. What is the proper width of the spark gap on the spark plug?
99. How does the timer work?
100. Why does not the generator begin charging the battery until the engine has reached a certain speed?
101. At about what car speed, in high gear, does the battery begin charging?
102. How does the high tension magneto work?
103. How can you test whether a miss fire is due to the ignition?
104. How can you determine which plug is failing to fire?
105. What could cause an irregular or jerky running when all cylinders are firing?
106. How does the muffler "muffle?"
107. Why do motorcycles make more noise than automobiles?
108. What pressures are used in automobile tires?
109. Does the gauge pressure include atmospheric, or not?
110. How does the dial pressure gauge work?
111. Why is the steam automobile more powerful than the gasoline one? Or is it?
112. Why is there no need for gear shift in the steam automboile?
113. Why cannot the electric automobile go as fast as other kinds?
114. What is gasoline?

115. What is meant by "high test" gasoline?
116. Why does the oil in the crank case get bad?
117. Does the automobile ammeter show the current taken by the electric starter?
118. How does the locomotive reverse?
119. How does the air signal on the train work?
120. Where does the electricity for lighting a train come from?
121. How hard can a locomotive pull?
122. Can a locomotive pull be actually measured?
123. How many horsepower has a locomotive?
124. How much water does a locomotive use in an hour?
125. How much coal does it use in an hour?
126. What is the fastest a locomotive has ever gone?
127. What is the fastest an automobile has ever gone?
128. How is the speed of an aeroplane measured?
129. What makes a baseball curve?
130. Why won't the aeroplane engine run as well very high up as it does on the ground?
131. How high has a balloon ever gone?
132. How do they get the water into a locomotive boiler when steam is up?
133. Why do different locomotives have different numbers and sizes of wheels?
134. How steep a grade can a locomotive go up by itself?
135. How much higher is the outside rail than the inner one, on a curve?
136. What is meant by the "per cent" of a grade?
137. How does the safety valve work?
138. How does the track sander work?
139. Where is the sand carried on the locomotive?

It seems to me that a high school pupil's course in physics should answer these questions for him—or her. Not only these, but a great many more of the same general class. It is up to the teacher to be able to answer them, or at least to be able to direct the inquirer to an easily accessible source of the information. In most cases the equipment of the physics laboratory should consist partly of the literature—books and magazines— which will answer them. Most of them are not answered in the high school texts, except it be in such a remote and indirect way that no ordinary individual would see the implied answer. Probably no text should answer all such questions directly. At present there is a demand that our texts include, a great deal more than formerly, the discussion of applications of the great physical laws, and I think that demand is a wholesome one. However, I do not think it is the ultimate in method.

I believe that we shall gradually come to the project method in practically all our science teaching, so that no one text can possibly contain the course. In that case our texts will probably become briefer instead of longer, as is the present tendency, and carry only a commonsense discussion of the physical laws from the theoretical standpoint, with a very brief discussion of a practical illustration or example of each, followed by a rather

extended list of the other practical applications of the law. Learning the truths by means of their applications will then have to be left to the project, carried on in the laboratory so far as possible, but outside to a considerable extent. I have set forth the above questions merely as examples of what the physics teacher who really fills his job is up against. Know the laws and how to demonstrate them, both experimentally and mathematically, but this above all: *Know how they touch life.*

In a preprint from the forthcoming annual report of President Judson of the University of Chicago, attention is called to the fact that in the final gift of Mr. John D. Rockefeller, December, 1910, it was stipulated that $1,500,000 should be reserved for the erection of a University chapel. Under the architect appointed, Mr. Bertram A. Goodhue, of New York, the plans are proceeding steadily. This building, which is expected to be a beautiful specimen of Gothic architecture, will be adapted for all general religious services, and for such formal services as the various convocations. It will be erected on the east side of the block in which the President's house stands and will have a tower approximately 216 feet high. The highest towers at present on the quadrangles are those of the Harper Memorial Library with a height of 135 feet, and the Mitchell Tower 127 feet in height.

NINETY-NINE PER CENT FAVOR METRIC STANDARDIZATION.

Out of 58,226 petitions relating to exclusive use of metric weights and measures in U. S. America, now in the keeping of the Bureau of Standards, Department of Commerce, 57,800 petitions or 99.27% favor this progress, and only 426, or less than 1% oppose it. This unqualified endorsement of metric standards for U. S. America is brought out in the analysis just completed at Washington by representatives of World Trade Club of petitions sent to President Wilson and America's national legislators by prominent persons and powerful commercial, manufacturing, civic and fraternal organizations of U. S. America. Some of these petitions represent unanimous resolutions passed at conventions of organizations with thousands of members.

The petitions have come as a result of the efforts of World Trade Club of San Francisco and the Metric Association of New York in explaining the great advantages of world-wide standardization of weights and measures. The petitions were referred to the U. S. Department of Commerce, and without cost to the United States Government, World Trade Club had them carefully counted and classified under the direct supervision of Mr. W. Mortimer Crocker of 156 Fifth Avenue, New York City.

New petitions are coming every day. The classification to date shows the following distribution of petitions: Manufacturing concerns, engineering concerns, engineers, architects, and contractors were 9,968 in favor and only 154 against meter-liter-gram. Chambers of commerce, trade organizations, exporters, importers were 9,974 in favor and only 51 against meter-liter-gram. Educational institutions, beneficent organizations, individuals in professions were 22,443 in favor and only 74 against meter-liter-gram. Similarly, in all other vocations, although petitioners were free to declare for or against meter-liter-gram, less than 1% objected; and over 99% favored metric standards exclusively.

SOME IMPORTANT PHASES OF GEOGRAPHY.

By FRED K. BRANOM,
Geography Department, Chicago Normal College.

TREND OF MODERN EDUCATION.

One of the important questions which a geography teacher continually has confronting him is, "What is the goal of education in our country?" The goal of education has been defined recently as follows: "Education in a democracy, both within and without the school, should develop in each individual the knowledge, interests, ideals, habits, and powers whereby he will find his place and use that place to shape both himself and society towards ever nobler ends." (Cardinal Principles of Secondary Education, The Bureau of Education Bulletin, No. 35, p. 9, 1918). This means that as a citizen, a person must be able to take his part in the local, state, national, and international affairs of the day; as a worker he must adapt himself to a rather complex economic order and as a man of leisure he must be able to conduct himself sanely.

The World War has had an important effect on our mode of living and thinking. Man today is asking the meaning of various things and he is seeing new visions. Great political and industrial movements are taking place, many institutions appear to be tottering and a new world is awakening. Education has the leading part to play in this great onward movement. With such great responsibilities placed upon us, geography teachers are examining with new zeal the course of study. Questions are being asked concerning the advisability of teaching certain material, about the adaptation of the material to the pupils and about the proper methods of teaching. Is it true that if the material were selected, arranged, and taught properly that we could do better in six or seven years what we are doing now in eight years in the grades and that geography would find a hearty welcome in the high school? Such questions deserve our consideration, and Professor Judd has struck the keynote when he says that "the feeling has been steadily gaining strength that our generation must shake off institutional traditions of a past age and organize a sound scheme of democratic education." (Judd, Charles H.: *The Evolution of a Democratic School System*, 1918, Houghton, Mifflin Co.).

WHAT IS GEOGRAPHY?

Geography has undergone several important changes during

the last century and it is only recently that life has been recognized as a very essential factor. Until about the middle of the nineteenth century, geography consisted chiefly in memorizing answers to questions and in the location of places. Some of the text-books were entitled "Geographical Catechism" while others well might have been given such a name. Memory work was encouraged because it was thought that children had better memories than judgment.

Description gradually found its way into geography and by the end of the nineteenth century, geography was considered as a study of the earth and its people. The subject consisted chiefly of physical and locational geography. Life was given a secondary place.

As long as geography was thought of merely as a study of the earth and its people many things were included. It was a scrapbag into which went a mass of unrelated material. Confusion resulted and many people had the idea that geography was made up of the remains of various subjects, with locational geography as the center and memory work radiating in all directions. The child was given a condensed knowledge of the world and he was supposed to be a walking encyclopedia. Fact after fact was presented in almost the same way. Places, many of which the child never would have any occasion to use after leaving school, such as capes, peninsulas, straits, isthmuses, bays, oceans, lakes, rivers, mountains, plateaus, plains, and cities were located; the origin and meaning of many geographical names and the nicknames of the states were taught; and much time was spent in drawing the outlines of states, countries and continents by trying to reproduce the exact maps in the book. Life was mentioned occasionally but it was relegated to the background. The life of the school was not connected with the life outside the school. Is it any wonder that people began to question the teaching of geography and to ask "What is it?"

During the last ten years, geography has been given another meaning and the life element is occupying as much attention as the physical features. Geography is considered as a study of the earth in relation to life or the relation of life to its physical environment. Salisbury well expresses it when he says that geography "is to center about the influences of earth features and earth resources on the distribution, character and activities of life—life of all kinds.—It is actuated by the high motives of all science, one of which is the desire to render its truth service-

able to mankind. Its field overlaps, in varying degrees, the field of geology, physical geography, meteorology, botany, zoology, history, economics and perhaps other sciences. But it uses the facts and principles of these sciences in explanation of the distribution, character and activities of life." (Salisbury, R. D.: *Geology in Education, Science*, p. 334, April 5, 1918.)

Education has been affected greatly by the World War. Probably no subject has been influenced to such an extent as geography. When we began to read about places of which we had no knowledge we commenced to use our atlases and maps and we learned that this world is not so large after all. Our attention was turned to our own country and many were surprised to learn that the United States produces about three-fourths of the world's copper, two-thirds of the world's petroleum, one-half of the world's coal and iron, four-fifths of the world's corn, three-fifths of the world's cotton, one-fourth of the world's oats and one-fifth of the world's wheat. Our country has more than one-half of the known coal in the world, large deposits of iron and most other minerals, much undeveloped water-power and one-fourth of the land is forested. About one-half of the total area of the United States is available for farming and one-half of this is improved. We have the finest transportation facilities in the world, having not only about as many miles of railroad as all the other countries combined but also a system of great lakes. Thus we can see why the United States was an important factor in winning the war and why it is that we must take an active part in the affairs of the world. Can a country with such great resources and which in a very short time will be manufacturing for one-half of the world and will be carrying one-half of the world's commerce remain to itself? Rapid transportation by land, water and air, and the overcoming of time and space by the telephone and telegraph have made it impossible for such a resourceful country to remain in the background. Thus the importance of geography is readily seen. It teaches not only the location of places, commercial and industrial activities, but it instills in the minds and hearts of the children a love for this country, and above all, it shows the interdependence of man while at the same time it shows his dependence on nature. It deals more intimately and fundamentally with the welfare of the human race than any other science and fulfills the aims and the goal of education as given in the beginning of this paper. Geography should teach men not to dislike one another just because

they are different but it should show why they are different and interesting and how they are related.

The Teaching of Geography.

As long as geography is taught by a certain formula of dried facts it never will be interesting, but an inspiring and sympathetic teacher bringing out the big issues in each problem will be the guiding factor in contributing to the welfare of man. The subject of geography covers so much ground that we cannot expect a person to know everything about it or even a little something about everything which it includes, but we do expect him to have a knowledge of some of the things which geography covers and a real mastery of a small portion of them.

When a child enters school he has a rather large mass of geographic material which he began collecting shortly after birth. His preschool activity is to be carried into the school and it is to be enlarged and directed during the first few years by home geography. The home and its surroundings have a wealth of geographic material which may be obtained by a little search, and this material furnishes a basis for the study of the world. Old experiences must function constantly in obtaining and interpreting new experiences. Hence the process of learning which begins shortly after birth and ends with death is the gradual accumulation of related material based on our old experiences, it is the building of a world image. The duty of the school has been stated very clearly in the following words: "But if each one of us must do his own world building for himself, must see with his own eyes, hear with his own ears, image with his own imagination, classify according to his own purpose and be convinced of logical necessity through his own feeling of conviction, can the school do anything that is really worth while for him?—The school can do only one thing—it can offer a carefully selected environment in reaction to which the learner will use his own mind in socially profitable ways." (Moore, Ernest Carroll: *What is Education*, pp. 136-137, Ginn and Co., 1915).

The growth of the pupil should be progressive. The course of study should be so planned that the pupil is kept at something which is new and real, which is adapted to his capacity, and which is related to his former knowledge. It is to develop relationship by thinking. Much time is lost by repeating the same subjects in different grades while at the same time the love for geography is retarded.

To furnish the correct environment for the pupils several types of lessons are useful in the teaching of geography. Of course the only way of teaching is to follow the natural development of the child, but if one type is used continuously in motivating the lesson, lack of interest and attention will result.

Some of the more useful types in the teaching of geography are: (1) the problem-project lesson, (2) the journey lesson, (3) the review, (4) the topical lesson, (5) the type study lesson, (6) special reports, (7) dramatization, (8) the question and answer lesson, (9) the story lesson, and (10) the drill. There is no distinct line of demarcation between the types, in fact, several types may be used in one lesson, yet it is helpful to consider the material from the various viewpoints.

The Problem-Project.

A problem of considerable difficulty is a problem-project. (Branom, Mendel E.: *The Project Method in Education*, p. 145, Badger and Co., 1919). It may be considered as a problem of considerable difficulty arising from a situation and it involves the accumulation, the consideration, the interpretation and the evaluation of a mass of material for its solution.

The particular form of the problem is not nearly so important as the fact that the problem is the pupil's problem and that he has a keen interest in it. The pupil must feel a need for it. The duty of the teacher is to see that the pupils have the right sort of material such as maps, pictures, museum materials, magazines, newspaper clippings and supplementary readers from which to get problems and to solve them. It is indeed a waste of time in having pupils browse among a large mass of material when a few specific, well-directed instructions eliminate this.

To make clear what is meant by the problem-project a brief outline of a lesson on Brazil is given. Of course each teacher has his own particular motivation and the method of procedure is determined largely by him.

I. Preparation: Examine a population map of South America and note the population of the different regions.

II. Problem raised: Account for the sparse population of the Amazon Basin.

III. A consideration of (1) location, (2) climate, (3) vegetation, (4) surface features, (5) navigable streams, railroads and roads, (6) products of the forest, (7) mineral, pastoral and agricultural development, (8) character of the native population,

(9) competition of other regions and (10) difficulty of securing immigrants.

IV. Problem solved: The pupils will give their conclusion from the mass of material presented.

A problem may occupy one period or it may occupy several periods. Subordinate problems may arise from the main problem. Sometimes pupils are not able to solve the problems from the material collected and this is to be expected. There are many problems in life outside of school which are not solved satisfactorily and since the school is life there must be some unsolved problems in school.

The remark is made occasionally that if the problem-project method is used the course of study cannot be followed, that it is impossible to teach the work as outlined in geography. The course of study is a guide and an inspiration, not a taskmaster. The problem-project does not make war on any good course of study, but if used, it does mean the elimination of much useless material in some courses of study. If the material cannot be taught so that the pupil has a problem of his own to solve, in most cases it is safe to say that the material should be cast aside.

The Journey Lesson.

The journey lesson gives the pupils an acquaintance with the world. "The imaginary journey appeals to the play instinct of the child, requires the exercise of a vivid imagination, and when wisely used it becomes a profitable means of geography study. It brings reality into work, requires definiteness in planning, and is quite commendable when not overworked. It turns memorizing of facts into the enjoyment of present experiences, develops a sense of distance as measured by time or expense, gives familiarity with methods and routes of transportation, and develops an acquaintance with the facts concerning distant places, and the customs of their people." (Wilson, H. B. and G. M.: *The Motivation of School Work*, p. 147, Houghton Mifflin Co., 1916.)

The journey lesson necessarily lays much emphasis on the locational, descriptive and informational type of geography. Place geography which was taught formerly with no relation to anything is taught here with great advantage.

There are various methods of motivating and presenting a journey lesson and no two teachers conduct a lesson in the same way, but to give an idea of what may be done in a journey lesson

I shall give a lesson which was given with much profit to a fifth grade class. The journey occupied eight days.

JOURNEY FROM CHICAGO TO THE PACIFIC COAST AND BACK HOME.

I. Selection of route: By means of railroad maps of the United States and railroad folders and pamphlets the pupils noticed the different routes which they might take to the Pacific Coast and the points of interest. After careful consideration and some discussion the pupils decided to take the Atchison, Topeka and Santa Fe Railroad to San Francisco. (Classes have gone in groups over different routes but when they did so all met at San Francisco or some other Pacific port.)

II. Preparation for the journey: The pupils decided what they would take with them, such as clothing and money. All did not take the same articles.

III. From Chicago to San Francisco: As the pupils traveled they noticed the things of interest as they came to them, such as plains, plateaus, mountains, agricultural regions, grazing regions, mining regions, forested regions, fruit orchards and fisheries. The relation of well watered plains to agriculture, of the arid land to irrigation, dry farming and grazing; and mountains as forest reserves, pleasure resorts, sources of minerals, sources of streams, and barriers to transportation and communication were emphasized. States passed through were named and brief stops were made at places of interest. The pupils described what they saw and good short descriptions were given. Letters, which for the most part described the life of the region, were written for a little booklet which the class was making. Stereographs, pictures, text-books, supplementary readers and all available material were used.

IV. From San Francisco back to Chicago: The pupils decided to return home by way of the Pacific Ocean, Panama Canal, Gulf of Mexico, Mississippi River, Illinois River, Chicago Drainage Canal, and the Chicago River. The climate, products, vegetation, people and cities were noticed. Short stops were made at Panama, New Orleans and St. Louis.

V. Illustrated lecture describing the journey: To make the trip appear as real as possible and as a final impression an illustrated lecture by means of the lantern was given by the pupils. The slides consisted of geographic scenes along the route which the pupils had passed. Another class was invited to attend the lecture and the result was well worth the effort.

A journey lesson may occupy one period or it may occupy several periods. The interest of the class is the guiding factor. A beginner should not attempt very long trips at the start, but as the teacher increases in power the journeys may be lengthened. Journey lessons may be given in any grade but of course the character of the work will vary with the grade.

The Review Lesson.

The review lesson in the hands of many teachers is nothing but a cramming process. The pupils go over the past work with no new problems and the recitation is conducted in the old way. A review conducted in this way is a waste of time and it teaches the pupils poor habits of study.

To an increasing number of teachers the review does not mean the cramming process. The pupils have real problems to solve and they think of the material and arrange it in a different way. The pupils are led to see the previous work in a new light and from various viewpoints.

Recently a visit was made to an eighth grade class which was studying about wheat and the exporting of it. To see whether the pupils really understood what they had been studying, a few were sent to the the board without any previous instructions and were told to show in pictorial form the journey of the wheat from the field to New York City The results were surprising, yet highly encouraging. Each pupil in the space of about ten minutes put into graphic form the solution of his problem and it showed just what relationships he had formed in his mind. The drawings showed (1) rolling fields of wheat, (2) cutting the wheat and putting it in shocks, (3) threshing, (4) hauling the wheat to the elevators, (5) elevators, (6) wheat being taken by railroad to Superior or Duluth, (7) whalebacks on the lake, (8) map of the Great Lakes showing the chief cities, (9) railroad or Erie Canal and Hudson River to New York City. The next day to the teacher's surprise and delight, several of the pupils had the journey traced on large paper and two new scenes were added, (10) ship steaming from New York City, and (11) map of Europe showing the ports to which the wheat might be taken. The pupils were not instructed to do this but they became interested and they did it because they enjoyed it and felt they were doing something worth while.

Map sketching which is done usually in a half-hearted way became play. Will not the pupil remember a rough sketch of a region better if he has it connected with something vital? How

many of us have spent many hours learning to draw or to copy the maps in our books with no purpose except to please the teacher? How many of us can draw the same maps today? It is better to be able to make thirty rough sketches of different regions in thirty minutes than to spend thirty minutes in making one map.

In a fourth grade room the pupils had been studying about the customs and occupations of certain groups of foreign people. In order to leave lasting impressions, the pupils acted the life of the people. They put themselves into the work with all seriousness and the work was summarized in a beneficial way. Dramatization appeals to the child but in order to dramatize the work the pupils first must know it.

The last few paragraphs may suggest something about examinations and text-books. One of the main points to keep in mind concerning examinations is that there are various ways of giving examinations and that there are various kinds. Text-books are a guide to the pupils and teacher and probably have an important place in the American school, but the teacher who assigns so many pages in the book to be learned for the next lesson is teaching memory work, not geography. A text-book is only one of the sources which furnish geographic experiences. Just because examinations of a certain type were given to us when we went to school and just because the teacher was afraid to get away from the text-book is no reason why we should do likewise. Remember that "the old order changeth, yielding place to new, and God fulfills himself in many ways, lest one good custom should corrupt the world."

If geography is going to function properly, it must enter into the life of the child. There are no other subjects, unless they are modern history and sociology, which play such an important part in our lives, and if we can give to the pupils that sympathetic understanding of the world which is so essential to the welfare of man, geography will have performed its share in the education of the American youth.

GOLD AND PLATINUM PLACERS IN THE TOLSTOI DISTRICT.

The Tolstoi district includes an area about twelve miles wide by twenty miles long, which lies on the flanks of Mount Hurst. Most of the district is in the basin of Tolstoi River, on the branches of which placers that yield gold and platinum have been worked for several years. The topography, geology, climate, vegetation, and animal life of the district, the producing placers, and the economic factors that affect mining are described by G. L. Harrington in Bulletin 692-F.

PHYSIOLOGY IN OUR SCHOOLS.[1]

By W. E. Nelson,

Superintendent of Schools, Sabetha, Kans.

We are rapidly reaching the stage where great changes in our courses of study must take place. Some changes have already been made but the work in physiology is not receiving the attention it deserves. Not long ago the course in high school civics was extended from eighteen weeks to thirty-six weeks because so many students failed in their examinations; too much work was attempted for the length of time; but the number of physiology failures while perhaps not so great from the standpoint of grades, has been as great if not greater when measured in terms of real value to the students' experience. So long as people will be satisfied with formal teaching, giving folk catch phrases as "a sound mind in a sound body" and basing the entire work upon a half credit earned in passing the examinations over stuff crammed into the mind as so many facts, our teaching of physiology will be for the most part a failure. Mere words may be good and true but almost wholly purposeless and meaningless. When shall we learn that physiology is a practical subject—should be a required subject with adequate time for gaining a thorough knowledge of the work?

Before discussing the difficulties standing in the way of efficient work let me mention some facts to challenge our attention to the pressing need for this subject, and then state the aims of physiology teaching as set forth in the state course of study.

First, human life is the paramount issue with mankind, and yet Spencer tells us that one-half of life is thrown away.

Second, the needless cost of contagious diseases, in other words preventable diseases, for one year in New York city mounts into the millions of dollars and 28,000 lives annually are sacrificed victims of neglect. Add to the wages lost, doctor bills, and burial expenses of those who die, the expense caused by those who recover from sickness. Then add to these two classes the expense of preventable sickness that is not communicable but classed as preventive, such as indigestion, troubles caused by lack of sleep, adenoids, defective vision, spinal curvature, etc., and the economic loss is enormous. Wouldn't it be better to use

[1] Read before the Biology Round Table, State Teachers' Association, Topeka, Kans., Nov. 7, 1919.

this money to endow schools, lectureships and journals necessary to teach preventive hygiene in every section of this great country?

Third, statistics tell us that the diseases of old age are becoming common in middle life.

Fourth, during the last thirty years there has been an increase of one hundred per cent in deaths due to diseases of the heart, kidneys and other organs.

Fifth, thousands die annually of impure air; thousands die of typhoid, the filth disease, although we have made wonderful progress in checking its ravages.

Sixth, the work of shattering the nervous systems of the children in this country is increasing. We are producing an appalling crop of physical bankrupts.

Seventh, our cities spend at least six times as much money to prevent fire waste as to prevent life waste, while the latter is almost six times as great. This system makes property of more value than life.

These facts give us a glimpse of our problem, for the correction of such frightful mistakes must come through intelligence and our public schools are the greatest agencies in carrying out the campaign.

Now let us consider for a moment the aim as stated in our state course of study. "To promote the physical welfare of the child is the principal aim in teaching school physiology. This includes a knowledge of conditions favorable to growth and conducive to health and bodily vigor. Hygiene and sanitation treat of these facts. To teach the structure and functions of the body without hygiene and sanitation is to miss the highest value of the subject, whatever other values may be realized. On the other hand, to teach hygiene and sanitation without the elements of anatomy and physiology is to build on the sand with no scientific basis. Let this foundation then be adequate to an intelligent understanding of hygiene, but do not give all of the time and effort of the class to laying the foundation. Physiology properly taught is one of the most practical utilitarian subjects. The true scientific spirit should pervade the teaching of school physiology. It should be related to every day activities and conditions that affect health and should be made concrete and personal. Moreover the teaching of hygienic facts must be transformed into hygienic actions and hygienic actions into hygienic habits." Here is your program as outlined by the state course. There isn't a teacher within the sound of my voice

who can approach that aim in the time given for this work.

Now for our difficulties:

First, hygiene and sanitation are studied for nine months in the fifth grade, while physiology and hygiene are studied nine months in the seventh. When we reach high school, eighteen weeks are devoted to this subject in the junior year, and required only of those who plan to teach. Now beginning with the first grade in our public schools and passing through the high school, we note that mathematics begins the first year and extends through the eight years of the grades and at least two and one-half years in the high school, possibly four. English is the same, though it may not be called English in the early years. History begins not later than the sixth, often times earlier, and may be carried by the student through every year until graduation from high school. But to teach health, the laws of life, and the organic functions of the human body—this matter is insignificant in comparison with the above named subjects, and may be gained in the short space of time allotted to it by means of the text, a note book, and possibly some demonstrations with a beef heart. We must go to work diligently and seriously to get more time for this work. To call physiology one of the most practical utilitarian subjects in our course and attempt to learn enough to be of real value in so short a space of time is little short of mockery.

In the second place we lack trained teachers. At the present time physiology is a sort of foot-ball in most of our high schools. About the only requirement called for is the A. B. degree. Special training along this line is not necessarily demanded. Now when we consider the preparatory work offered below college grade, and with little or no preparation thereafter, we have little reason to expect much from our teachers in way of instruction and inspiration. With this lack of trained teachers necessarily goes a poor type of instruction. The work in the grades is so poorly taught, generally speaking, that the child not only fails to appreciate this subject but usually forms a strong dislike for it. To teach the facts of hygiene, recite upon them and issue grades or credit accordingly, is little short of useless. We need a great deal of material filled with human interest, and the teacher who is well prepared and really has a love for this work can make the subject inspiring rather than merely so much perfunctory work. The teacher may spend weeks in having recitations about the skin, pores, evaporation, and discharge of impurities, but to require shower baths will do more good than all the or-

dinary type of instruction. The child's attention may be secured more quickly for cleanliness of hands, and of teeth, by honoring him for it than by pages of Do's and Don't's in a textbook. Human interest may be gained in learning what city parks and outings do for sickly children; how the work of welfare committees improves health conditions in factories; how life insurance companies will not take risks upon lives of men and women who are addicted to intoxicating liquors and other forms of dangerous habits. To start out with a discussion in story form will do more by far than a dry recitation upon the number of bones in the human body or the evils of intemperance. When epidemics appear and absences are numerous, that is the time to make a lasting impression by asking pupils to keep track of absences due to these contagious diseases and follow up this scheme with a record and search for conditions favorable to this disease as well as means of prevention. This plan will do infinitely more than a dry recitation about people who die of plagues a thousand miles away. Our task is that of trying to get folk to live according to the laws of hygiene in an environment that is often times distinctly unhygienic.

Now what do we observe in connection with our high school teaching? First of all—it is a cramming process. There is more work outlined than can be covered in eighteen weeks if the work is to be done in a thorough manner. The text book, note book work suggested, and a certain amount of laboratory work in this short space of time, produce a jumble in the student's mind and he is more interested in getting just enough in his mind to pass examinations than he is to really understand the subject matter. On the other hand, if the work were extended throughout the year, the text used that we now have, although it is subject to rather severe criticism, supplemented by good assignments in other texts, together with a good laboratory course, and considerable outside reading, the results would soon begin to show. One unit of this work is too short, but if we can introduce into our high schools a one year workable course we could do nothing finer to advance the best interests of the students. The type of instruction now given is decidedly detrimental to real scholarship as well as to practical purposes. The teacher wishing to prepare the student for the normal training examinations selects such work as will most likely be called for, so the answers are memorized by parts, a-b-c-d. Note the questions extending over a period of years and you will observe that with a fair note book

and a cramming process worked to the limit, a student can pass the examination and yet know very little about the subject. Such work is unscientific to say the least.

We need a strong laboratory course in connection with our work and thus should place this subject on an equality, at least, with the other sciences. For example take the chapter on tissues and cells; too many teachers talk about these structures to a class as if they should have a perfectly clear understanding. As a matter of fact a little questioning outside the words of the text will reveal a vagueness in the minds of most students. It was the microscope that gave man a knowledge of what every living structure really is and the fashion after which it is constructed. Without time for a careful study and a certain amount of demonstration, the material in this chapter in deed and in truth becomes a "sell." We do not think of teaching other sciences without laboratory work; then why this one? Is it more important that a student should know through experiment the structure of plants and the laws of phsyics than that he should have a practical knowledge of the human body? Members of a class in zoology one year volunteered the information to me that after taking that course with laboratory work, many mysteries in physiology work had been made clear to them. This was the first time that the real significance of a physiology laboratory course came to me.

In addition to more thorough text book work where the emphasis is not placed upon passing the examinations, and a good solid laboratory course placing phsyiology on the same basis with other sciences, we need to add a third factor which remains practically unknown in the average high school: the value of wide reading as a form of experience. We are realizing more and more that the student must be prepared for actual conditions outside the school and not send him out unprepared to assume responsibilities in the social group. Many hygienic activities are carried on by the group, managed oftentimes by men especially trained for such work, but nevertheless there is a certain amount of oversight by the group. "We are too well satisfied with our technique of systematized learning." We need to broaden the student's understanding by historical, narrative and biographical sketches in connection with our class room work. We need to emphasize information from the text, to be sure, but we need development through wide and varied readings. We must not expect the student to retain all of this material, but

nevertheless the influence of such reading leaves its effect upon the general attitude of the mind that challenges our most serious attention. As one well known authority has said: "Reading experience is coming more and more to be valued as a means of forming mentality." There are many phases of activities in which actual experience and experience through accounts of others seem to be almost identical. When we reach lessons on food and food habits, for example, we need extensive reading which will actuate the planning of well balanced rations. Absolutely nothing is gained from memorizing the meagre information in the text. The diseases such as malaria, yellow fever and typhoid, for example, are read over, to be sure, but no lasting impression is made. The very thing we expect to do by these topics is not done at all. The work is meaningless. These are the things that need to make a lasting impression on the student's mind. Now if we had time to stress experience through readings, followed by discussions, we should make headway. For example, take some statement from a text book or pamphlet such as this: "The death rate in the Panama Canal zone was practically twenty times greater under French control than under American regulations." This fact merely as dry figures will not make a lasting impression on the student's mind but let him read an article such as appears in current magazines, an article containing the same fact throbbing with human interest, and his attention not only will be arrested but his sympathy will be aroused and the impression then will be permanent. The struggle that was waged against yellow fever in the south land and in Cuba; against bubonic plague on the western coast; struggles against the most insidious of adversaries are just as interesting as wars and struggles among nations. Heroic deeds in such accounts stand out as prominently and the results are those of positive upbuilding rather than devastation and destruction such as always follow in the wake of war. In our text book work we teach about a certain bacillus—travels, habitat, physiological effects, etc., but a grand lesson of social relationship we are likely to lose sight of: geographical and racial conditions, people most susceptible and those who seem to be immune, how affected by occupations, climatic and sanitary conditions. Go back to the days of the Pilgrim fathers and what hold had tuberculosis upon their red-skinned neighbors? Primitive peoples the world over have been greatly reduced through the diseases of civilization. We must not stop in our study of tuberculosis with the matter of housing,

segregation and other means of prevention. The question of low wages means malnutrition and lowered vitality; lowered vitality means susceptibility to attack. We need more stress placed upon our work from a social standpoint. I have mentioned briefly only a few instances for the sake of illustration. We have a wealth of material on preventable diseases that we might use.

Advanced thinkers are beginning to demand a new profession —the profession of hygiene. This demand will not be supported extensively by the older generation but the young people in the schools of today will be responsible in bringing this change, when they take their places with the workers in every day affairs. The social group will have to exercise a greater degree of control over all forms of activity that affect the common welfare. The medical profession which is most closely related to the profession of hygiene will be responsible to society only in so far as society is able to hold it responsible. Quackery flourishes in an ignorant community. The different schools of medicine today conflict with each other and too often hinder progress. In spite of these opposing views, prejudice must be put aside. The fact must be recognized that there is only one body of truth which must be found through the scientific method, thus approaching as rapidly as possible toward this new ideal. If the public does not make this demand, who will make it and who will enforce it? Public sentiment is the greatest means of securing a high grade of service from any professional group. The day has passed when we can permit health to be squandered needlessly.

THE MONKEY STOPS CLIMBING.

By William F. Rigge,
Creighton University, Omaha, Nebr.

In the last December number of this journal, p. 815, Wilbert A. Stevens, Township High School, Lockport, Ills., takes exception to both the theoretical and practical solution of the problem of the climbing monkey that I had presented in these pages two years before, December, 1917, p. 821. This problem, as may be remembered, gave the case of a rope passing over a fixed pulley with a monkey clinging to one end while his equal counterpoise was attached to the other, and asked what happened to the counterpoise when the monkey climbed the rope. I said that it remained stationary, for the reason that, as the monkey could not change his weight, he could not increase his pull on the rope. I backed this up by an experiment in which a clockwork monkey weighing 240 grams was counterpoised over the nine-inch pulley of a fine Atwood's machine and climbed 80 cm. in a minute, while the counterpoise remained stationary.

As Mr. Stevens asserted that friction was to blame for the fact that

the counterpoise did not rise with the monkey, I had my doubts on the matter, because one-fifth of a gram was sufficient to destroy the balance. Let me add that the pulley had such a moment of inertia that its gross weight of 295 grams was practically equivalent to 150. To reduce this friction to still lower terms, the pulley was replaced by the beam of a balance so sensitive that 10 milligrams deflected the beam when the monkey and the counterpoise were attached. When the monkey started to climb, the counterpoise did go up for a moment, but it came down again and oscillated about its zero position with decreasing amplitudes. This confirmed me in my view.

However, discussion of the subject with my fellow professors convinced me that I was wrong and Mr. Stevens right in both theory and practice. In theory, because while the monkey cannot change his weight, he can change his acceleration, and this must be equalled by that of the counterpoise. This may be best shown if we let the monkey slide down the rope. As his pull is now lessened, the counterpoise must go down with him. For the same reason it must go up when he climbs, And again, if there were some weightless contrivance for shortening the rope over the monkey's head, because the pull is the same in both directions, both monkey and counterpoise must approach and go up together, just as equal boats must approach when the rope joining them is shortened. Placing this rope-shortening device in the monkey's arm muscles does not change the theory.

Now as to the experiments. In both, the force of acceleration was too small to overcome the inertia of the pulley and of the counterpoise. Taking out the last wheel in my clockwork monkey made him climb more than ten times as fast, and then both monkey and counterpoise went up together.

INCREASED OUTPUT OF ALASKA COAL.

The production of coal in Alaska in 1918 was 75,606 tons, valued at $411,850, according to the U. S. Geological Survey, Department of the Interior. This may be compared with 53,955 tons, valued at $265,317, in 1917. The production for 1918 was by far the largest in the history of coal mining in Alaska, being 40 per cent larger than the output for 1917, which was also greater than that of any previous year. It is believed that a substantial coal-mining industry has at last started in Alaska. The larger part of the output in 1918 came from the Matanuska field which yielded 63,092 tons. The remainder came from eight or ten small mines in different parts of the Territory. All these mines, except those in the Matanuska and Bering River fields and at Port Graham, produced coal for local use under free-use permits. About 12 mines were operated, employing 239 men for an average period of 254 days.

In the Matanuska field the Eska Creek mines were operated regularly throughout the year by the Alaskan Engineering Commission, to supply fuel for railroad and other Government use. At the Chickaloon mine, also operated by the Alaskan Engineering Commission, the work has consisted primarily of exploration and development, and only a small amount of coal, won incidentally, has been produced. In 1918 for the first time Matanuska coal was shipped beyond Anchorage. Private operations preparatory to mining were continued by two lessees in the Matanuska field. and some coal was mined by one of them, but their mines are not yet regularly productive. A detailed account of coal mining in Alaska is contained in a report on the Alaskan mining industry in 1918 just issued by the Geological Survey at Washington, D. C.

PROBLEM DEPARTMENT.

Conducted by J. O. Hassler.

Crane Technical High School and Junior College, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. O. Hassler, 2337 W. 108th Place, Chicago.

SOLUTION OF PROBLEMS.

626. *Proposed by Walter McNelis, Philadelphia.*

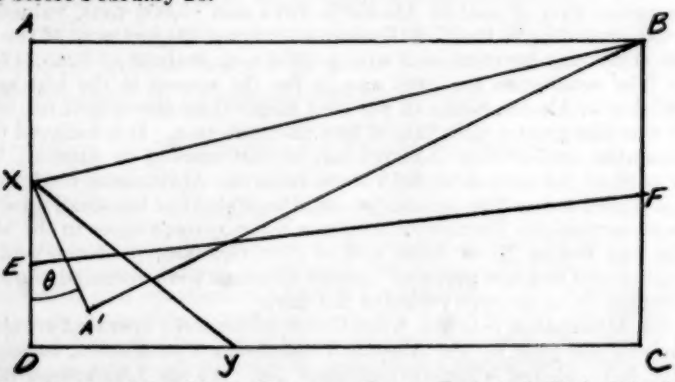
Prove the following equations are consistent and solve.

$$\begin{aligned}
50e_1+250e_2+100e_4 &= 6\\
265e_3+200e_6-250e_2 &= 0\\
110e_5-100e_4-200e_6 &= 0\\
50e_1+265e_3+110e_5 &= 6\\
e_1- \quad e_2- \quad e_3 &= 0\\
-e_1+ \quad e_4+ \quad e_5 &= 0\\
-e_4+ \quad e_6+ \quad e_9 &= 0\\
e_7- \quad e_8- \quad e_9 &= 0
\end{aligned}$$

627. *Proposed by Daniel Kreth, Wellman, Iowa.*

If x be any prime number except 2, the integral part of $(1+\sqrt{2})_x$ diminished by 2, is divisible by $4x$.

There was an error in the statement of each of the above problems when published in the November issue. Although the correction was noted in the December issue, the delays in printing have brought this issue out so late that this material for February is being written very soon after publication of the correction. Therefore we will not publish solutions of the problems 626 and 627 until April and solutions may be sent in any time before February 20.



628. *Proposed by H. C. Peterson, Crane Technical High School and Junior College, Chicago.*

Suppose a rectangular sheet of paper has vertices indicated by A, B, C, D, consecutively. Fold corner A over along line BX, X any point in AD; fold again so that XD lies in the direction XB making crease XY (Y in BC or CD); open and fold again so that DC lies in line XB making crease EF. Prove that XY and EF make an angle of 45° with each other.

I. *Solution by Hazel C. Jones, Danville, Ill.* [By folding.—*Ed.*]

Call the point of intersection of XY and EF, Z. After making the crease EF, unfold and fold again so that DX lies in the direction BX. Without

unfolding, fold again so that YC lies along the line XB. It will be seen that the straight angle made by a line drawn from the point where Y falls on the line XB through the point Z is divided, by the folding, into four equal angles each of which is an angle of 45°.

One of these angles, YZF, is made by the intersection of the lines XY and EF.

II. *Solution by J. Carl Kamplain, Student, University of Chicago.* [By using equations.—*Ed.*]

Let A′ be new position of A, when paper is folded over BX and let $\angle DXA' = \theta$. Then $\angle BXA' = 1/2\ \angle AXA' = 90° - 1/2\ \theta$.

Suppose BX and CD, both produced, to intersect at Z. Then $\angle BZC = \angle BXA' + \angle DXA' - 90° = 1/2\ \theta$.

Hence $\angle FZC = 1/4\ \theta$. $\angle YXD = 1/2\ \angle BXD = 45° + 1/4\ \theta$.

Hence angle between DC and XY $= 135° - 1/4\ \theta$.

Hence EF and DC make angles of 135° and 45° with each other.

Also solved by R. C. STALEY, A. PELLETIER *and* M. G. SCHUCKER.

629. *Proposed by Walter R. Warne, Carlisle, Pa.*

Give a solution by means of elementary plane geometry of the following:

If l, m, n be the perpendiculars from the center of the circumscribed circle on the sides of a triangle, show that

$$4(a/l + b/m + c/n) = abc/lmn.$$

I. *Solution by A. Pelletier, Montreal, Can.*

Let H be the orthocenter of ABC, and R, the radius of the four equal circles circumscribed to ABC, ABH, ACH, BCH.

From the equality

$$4R(ABH + ACH + BCH) = 4R \cdot ABC$$

we derive

$$a \cdot BH \cdot CH + b \cdot AH \cdot CH + c \cdot AH \cdot BH = abc.$$

But $AH = 2l$, $BH = 2m$, $CH = 2n$, hence,

$$4(amn + bln + clm) = abc,$$

or

$$4(a/l + b/m + c/n) = abc/lmn.$$

II. *Solution by William Bailey, Student in Dickinson High School, Jersey City, N. J.*

[This solution, Mr. Roray informs us, was the result of a request for a proof by synthetic geometry of the familiar formula tanA + tanB + tanC = tanAtanBtanC which is closely related to this problem.—*Editor.*]

Given triangle ABC with AD perpendicular to BC, BE perpendicular to AC, CF perpendicular to AB. Let $AD = h$, $BE = j$, $CF = i$, $BD = x$, $DC = y$, $BF = q$, $FA = p$, $AE = r$ and $EC = s$. To prove

$$j/r + i/q + h/y = jih/rqy.$$

$$h(x + y) = j(r + s) \quad (1)$$

$$y(x + y) = s(r + s) \quad (2)$$

$$x^2 + 2xy + y^2 - s^2 = j^2 \quad (3)$$

Subtract (2) from (3),

$$x^2 + xy + sr = j^2.$$

From this

$$xh(x + y) + hsr = jhj \cdot xs/xs = hij \cdot xs/yq.$$

$$x(js + jr) + hsr = jih \cdot xs/qy,$$

$$j/r + j/s + h/x = jih/rqy.$$

$$\therefore j/r + h/y + i/q = jih/rqy.$$

This at once reduces by similar triangles to

$$4(a/l + b/m + c/n) = abc/lmn.$$

III. *Solution by Nelson L. Roray, Metuchen, N. J.*

We have at once

$$la + mb + nc = 2\triangle [\triangle = \text{area of triangle.}]$$

or

$$2R(a/mn + b/ln + c/lm) = abc/lmn \text{ [R = radius circum-circle].}$$

But

$$R : a/2 = mc/2 + nb/2 \text{ [Ptolemy's Theorem.]}$$

or

$$R = (mc+nb)/a,\ (lb+ma)/c,\ (na+lc)/b.$$

Whence by substituting for R in equation (2) we get

$$4(a/l+b/m+c/n) = abc/lmn.$$

or

$$a/2l+b/2m+c/2n = a/2l \cdot b/2m \cdot c/2n.$$

or

$$\tan A+\tan B+\tan C = \tan A \cdot \tan B \cdot \tan C.$$

630. *Proposed by Herbert C. Whitaker, Philadelphia.*

A ship at sea sights two lighthouses, one due north, the other due east. After sailing N.35°E., 3 miles, the ship is equally distant from the two lights; and sailing on the same course one mile further, the ship is found to be on the same straight line with the lights. What is the distance between the two lighthouses?

I. *Solution by A. Pelletier, Montreal, Can.*

Let O, M, N be the three observing points, where OM = 3, MN = 1. Let X, Y be the two light houses. Draw OP perpendicular to XY and represent the acute angle ONX by x.

We have

$$OP = 4\sin x,\ OX = 4\sin x/\sin(55°+x)$$
$$PX = -4\sin x \cdot \cos(55°+x)/\sin(55°+x)$$
$$XY = -4\sin x/\sin(55°+x)\cos(55°+x) \qquad (1)$$

Now

$$XY/2 = PX+OM\cos x = -4\sin x \cdot \cos(55°+x)/\sin(55°+x)+3\cos x \qquad (2)$$

Comparing (1) and (2), we get, after a few transformations,

$$4\tan x/3 = \tan(110°+2x).$$

Solving by approximation, we find $x = 73° 53'$, and XY = 7.86.

II. *Solution by the Proposer.*

Let A be the east lighthouse, B the north lighthouse and C, D, E successive positions of the ship. Let CA = x and CB = y.

$$AD^2 = x^2+9-6x\cos 55° = y^2+9-6y\cos 35°.$$
$$2 \cdot \text{area ABC} = xy = 4x\sin 55°+4y\sin 35°$$

whence

$$x = 4.9371, \text{ and } y = 6.12117 \text{ and AB} = 7.864$$

Another solution was also received from the PROPOSER.

Late Solution. A solution to 624 from the PROPOSER was received too late for publication in last issue.

PROBLEMS FOR SOLUTION.

641. *Proposed by Walter R. Warne, State College, Pa.*

Eliminate x between the equations

$$x+1/x = y$$
$$x^5+1/x^5 = z.$$

642. *Proposed by Abigail Glenn, Student, Chicago Normal College.*

What value of b will make b^4+30b^2+25 a perfect square?

643. *Proposed by Walter R. Warne.*

The sum of three terms of an harmonic series is 11, and the sum of their squares is 49. Find the numbers.

644. *Proposed by H. C. Peterson, Chicago.*

Suppose a rectangular strip of paper with vertices A, B, C, D, consecutively (AB representing the length). Fold on some line, say EF (E on AB, F on CD) so that EA will intersect FC in point G, say, making EFG an equilateral triangle.

645. *Proposed by Walter R. Warne.*

If $abcs = 8\triangle^2$, where a, b, c represent the sides of a triangle, s the semiperimeter and $\triangle$ the area, prove the triangle is equilateral.

GEOLOGIC PROBLEMS IN THE MATANUSKA COAL FIELD.

The results of studies of the strata and of the structure in the Matanuska coal field, Alaska, made in 1917 by G. C. Martin, are reported in a paper just published in Bulletin 692-D. The paper includes sections showing the character, relations, and thickness of the beds of rock and coal at many localities, as well as a graphic section showing a tentative correlation of certain coal beds between places specified.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

The Warner & Swasey Company, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, 10109 Wilbur Ave., S. E., Cleveland, Ohio.

Please send examination papers on any subject or from any source to the Editor of this department. *He will reciprocate by sending you such collections of questions as may interest you and be at his disposal.*

QUESTIONS AND PROBLEMS FOR SOLUTION.

The following test was prepared by a committee in cooperation with the Society for the Promotion of Engineering Education.

SCHOOL SCIENCE AND MATHEMATICS is under obligation to Dr. L. L. Thurstone, Division of Psychology, Carnegie Institute of Technology, Pittsburgh, Pa., for permission to print this test. Please note, however, that it is copyrighted by Carnegie Institute.

335. *Test V, Physics.*

Will readers of SCHOOL SCIENCE AND MATHEMATICS *try this test upon themselves and send in the results? Answers will be treated confidentially.*

TEST V, PHYSICS, FOR COLLEGE FRESHMEN AND HIGH SCHOOL SENIORS.

(*Prepared for Society for the Promotion of Engineering Education, Committee No. 22 on Intelligence Tests.*)

Time Limit: 30 minutes.

Name.....

College..... Date.....

Do not open this pamphlet until you are told to do so by the examiner.

This is a test to see how quickly and accurately you can think. The result of the test will be used by your advisers in order that they may know more about your abilities.

On the inside pages there are 25 problems. In each case you are told exactly what to do. Notice the instructions carefully.

Do not ask any questions. If you come to a problem that you do not understand, go to the next problem.

You will be given only thirty minutes. Solve as many problems as you can in the time allowed.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO BEGIN.

(Copyright 1919, by Carnegie Institute of Technology. Form S-1531.)

1. The six links of a chain can stand 50, 60, 70, 80, 90, and 100 lbs. respectively. It has been decided not to load the chain more than half of its maximum capacity. What is the largest allowable load on the chain?

   Answer.....pounds

2. What is the power consumption of a tungsten lamp that uses 1.5 amperes at 110 volts?

   Answer.....watts

3. A boy exerts a force of 75 pounds. How much work does he do in helping to push a truck a distance of 100 feet on a level road if the truck weighs 3,000 lbs.?

   Answer.....foot pounds

4. What is the angular velocity of the earth?

   Answer.....degrees per hour

5. A metal ball weighs 100 grams in air and 90 grams when suspended in water. What is the specific gravity of the ball?

   Answer.....

6. What is the velocity of sound when a note which has a frequency of 275 vibrations per second has a wave length of four feet?

   Answer.....feet per second

7. The area of the large piston in a certain hydraulic press is 50 square inches, that of the small piston is one square inch. What load can

be supported on the large piston if a force of 100 pounds is applied to the small one?

Answer.....pounds

8. A tree which is 100 feet from a pinhole produces an image which is 1 foot high on a screen 5 feet from the pinhole. How high is the tree?

Answer.....ft.

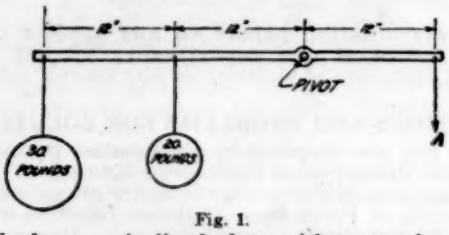


Fig. 1.

9. A ball rolls down an inclined plane with an acceleration of 20 cm. per sec., per sec. If it starts from rest, how far does it travel in seven seconds?

Answer.....cm.

10. What force is necessary at A in Figure 1 to balance the two weights on the other side of the pivot?

Answer.....lbs.

11. If the angle of incidence of a beam of light on a pond of water is 40 degrees, what is the angle of reflection?

Answer.....degrees

12. What is the pressure at the bottom of a tank filled with water if the tank is 30 cm. in diameter and 100 cm. deep? Neglect atmospheric pressure.

Answer.....grams per sq. cm.

13. If 1,000 feet of No. 18 copper wire has a resistance of 6.5 ohms, what is the resistance of 100 feet of the same wire?

Answer.....ohms

14. If 1,000 feet of No. 18 copper wire has a resistance of 6.5 ohms, what is the resistance of a wire of the same length and material and double the cross section?

Answer.....ohms

15. A certain bi-convex lens is placed at a distance of two feet from an object. An image is produced at a distance of one foot from the lens. The object is 1½ inches in diameter. What is the diameter of the image?

Answer.....inches

16. If it requires 0.1 ampere to operate a certain electric bell, and the resistance of the magnet winding is 10 ohms, what is the lowest voltage that will serve the purpose?

Answer.....volts

17. A storage cell with a resistance of 0.1 ohm is connected in series with a resistance of one ohm. What is the value of the current if the e.m.f. of the cell is 2.2 volts?

Answer.....amperes

18. How many grams of water at 80° C will be required to just melt 5 grams of ice?

Answer.....grams

19. A cylinder contains 1,000 cubic inches of oxygen at a pressure of 50 pounds per square inch. What would be the pressure in the cylinder if the gas were compressed to 250 cubic inches at constant temperature?

Answer.....lbs. per sq. in.

20. An anemometer on a steamer indicates a wind velocity of 28 miles per hour from the northeast. The steamer however is moving due northeast at a speed of 15 miles per hour. What is the actual ve-

locity of the wind?

Answer.....miles per hour

21. What force is necessary at R in Figure 2 to balance the weight? Neglect the weight of the lever arms.

Answer.....pounds

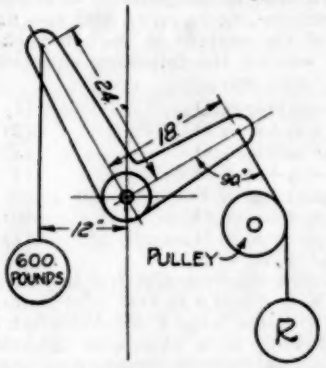


Fig. 2

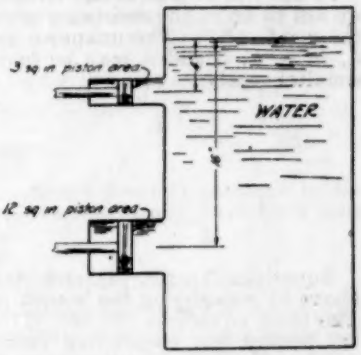


Fig. 3

22. Figure 3 shows a tank of water with two pistons. The force on the upper piston rod due to water pressure is ½ pound. What will be the force due to water pressure on the lower piston rod?

Answer.....pounds

23. A man exerts a downward force of 100 pounds. How much can he support with a tackle consisting of one fixed and one movable pulley?

Answer.....pounds

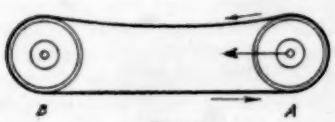


Fig. 4

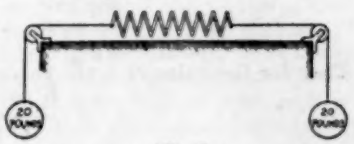


Fig. 5

24. Figure 4 shows two pulleys connected by a leather belt. The pulley A is the driving pulley. The bottom side of the belt is the tight side, and the total pull in it is 360 pounds. The pull on the slack side is 100 pounds less than on the tight side. What is the total pull on the shaft in the pulley A in the direction of the large arrow?

Answer.....lbs.

25. The elastic limit of the spring in Figure 5 is 70 lbs. It elongates one inch by a force of five pounds. How much would the spring be elongated by the two weights as shown in the figure?

Answer.....inches

SOLUTIONS AND ANSWERS.

328. *The Canal Problem published in the October, 1919, number.*

No correct solutions have been received.

333. *Proposed by H. J. A. Hackenberg, Manager, The Cleveland Instrument Co., Cleveland, Ohio.*

Can you devise (or locate) an equation for the current in the galvanometer of a Wheatstone bridge circuit when voltage of battery and resistance are given?

Solution by Robt. W. Boreman, Georgia School of Technology, Atlanta, Ga.

This is scarcely a practical problem for the Wheatstone bridge as used in practice, for measuring resistance is balanced so that there is no current flowing through the galvanometer. For an unbalanced condition, when current does flow through the galvanometer, it may be calculated

from a consideration of Kirchoff's laws: (*a*) The algebraic sum of all the currents flowing toward a branch point is zero. (*b*) The algebraic sum of all the electromotive forces acting around a closed circuit, or a mesh of a network of conductors is equal to the sum of the products ri around the mesh.

In the Wheatstone bridge circuit shown (and in the problem as stated) we are to know the resistance of each part—r_1, r_2, r_3, r_4, r_5, and r_6— and the e.m.f. "E." The unknown values of the current in each branch—i_1, i_2, i_3, i_4, i_5 and i_6 may be found by solving the following equations simultaneously.

$$\begin{aligned} i_1-i_2-i_3 &= 0 && (1)\\ -i_1+i_4+i_5 &= 0 && (2)\\ i_2-i_4+i_6 &= 0 && (3)\\ i_3+i_5+i_6 &= 0 && (4)\\ r_1i_1+r_2i_2+r_4i_4 &= E && (5)\\ -r_2i_2+r_3i_3+r_6i_6 &= 0 && (6)\\ -r_4i_4+r_5i_5-r_6i_6 &= 0 && (7)\\ r_1i_1+r_3i_3+r_5i_5 &= E && (8) \end{aligned}$$

Equations (1), (2), (3), and (4) come directly from the first law given above by considering the branch points *a*, *b*, *c* and *d* in the order named. The mesh equations (5), (6), (7), and (8) come from a consideration of the second law considering currents flowing in a clockwise direction around the mesh as positive and those in the opposite direction as negative. We get eight equations and have only six unknowns so one may be dropped from each set leaving the six independent equations to be solved for the six unknowns.

If it is desired to solve for only the galvanometer current i_6, it is easiest to do it by determinants using the following equations:

$i_1 = i_2+i_3$, $i_2 = i_4-i_6$ and $i_3 = i_5+i_6$. Combining these with (7), (6), and (5) above we get the equations: $r_6i_6+r_3i_3-r_2i_2 = 0$; $-i_6(r_6+r_5+r_4)+i_3r_3-i_2r_4 = 0$ and $i_6r_4+i_3r_1+i_2(r_1+r_2+r_4) = E$

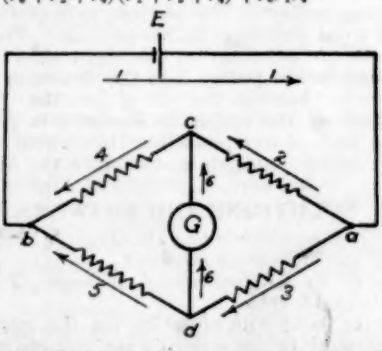
Writing D for the determinant

$$\begin{matrix} r_6, & r_2, & -r_2 \\ -(r_6+r_2+r_4), & r_5, & -r_4 \\ r_4, & r_1, & r_1+r_2+r_4 \end{matrix}$$

Then for the value of i_6 the galvanometer current, we have

$$i_6 = \frac{E(r_2r_5-r_3r_4)}{D}$$

From which $D = r_6r_5(r_1+r_2+r_4)-r_3r_4r_4+r_2r_1(r_6+r_2+r_4)+r_2r_5r_4+r_3(r_6+r_2+r_4)(r_1+r_2+r_4)+r_6r_1r_4$



In case it seems desirable to work out a specific case let us take the following: r_1, including the battery resistance and that of the leads, is 50 ohms. r_2 is 250 ohms. r_3 is 265 ohms. r_4 is 100 ohms. r_5 is 110 ohms and r_6 is 200 ohms and includes the resistance of the galvanometer. The battery has an e.m.f. of 6 volts. The following is a method of determining i_6:

$$i_6 = \frac{E(r_3r_5 - r_3r_4)}{D} = \frac{6(250\times110 - 265\times100)}{D}$$

$$D = [200\times110(50+250+100) - 250\times100\times100 + 250\times50(200+110+100)] - [-250\times110\times100 - 265(200+110+100)(50+250+100) - 200\times50\times100]$$

$$D = 8{,}800{,}000 - 2{,}500{,}000 + 5{,}125{,}000 + 2{,}750{,}000 + 43{,}460{,}000 + 1{,}000{,}000 = 58{,}635{,}000$$

$$\text{Then } i_6 = \frac{6\times1{,}000}{58{,}635{,}000} = 0.0001024 \text{ Ampere.}$$

Since the sign comes out plus, the current flows as assumed in the drawing. If it had come out negative, the flow would have been from *c* to *d* in the diagram.

GOVERNMENT IN TOUCH WITH OIL INDUSTRY.

The close contact of the United States Geological Survey of the Department of the Interior with the economic situation in the United States and its recognition of the need for the discovery of new oil fields in the immediate future is shown by the emphasis placed on geologic field investigations aimed at the discovery of new oil and gas reserves. Of the fourteen papers or short reports published in the annual volume of "Contributions to Economic Geology, 1918," Part II, *Mineral Fuels* (Bulletin 691), eleven relate to the possibilities of discovering new oil fields or of developing oil shales, whereas three are concerned with descriptions of coal fields. Three of the papers describe regions of favorable structure, with oil and gas possibilities, in Montana, one in North Dakota, two in California, one in Oklahoma, one in Arkansas, and one in portions of the Central Great Plains of Wyoming, Nebraska, Colorado, New Mexico, and Kansas.

Advance editions of these papers, distributed separately, were issued promptly as printed in order to place the information as soon as possible in the possession of the oil companies. The complete volume may now be obtained by addressing the Director of the U. S. Geological Survey, Department of the Interior, Washington, D. C.

WATER POWERS IN SOUTHEASTERN ALASKA.

Systematic investigation of the water resources of Alaska was begun by the United States Geological Survey, Department of the Interior, in 1906, and has been carried on in one or another part of the Territory to the present time. This investigation was undertaken to supply the need for definite information in regard to the quantity of water available for many uses, such as hydraulicking, dredging, and supplying power for mines, canneries, and sawmills.

The investigation of the water resources of southeastern Alaska was begun by the Geological Survey in cooperation with the Forest Service in 1915 and was designed to determine both the locations of water-power sites and the possible water power available. Since then the Geological Survey has maintained a number of gauging stations in southeastern Alaska throughout the year and has installed other stations in cooperation with individuals and corporations. The records obtained at these stations in 1918 are contained in a report entitled *Water-Power Investigations in Southeastern Alaska* (Bulletin 712B), by Geo. H. Canfield, which has been recently issued by the Geological Survey and can be obtained free of charge from the Director of the Survey at Washington.

A SURVEY REPORT OF COMMERCIAL EDUCATION.

No. 5 of Volume II of the *Supplementary Educational Monographs* is ready for distribution. It is entitled "A Survey of Comercial Education, in the Public High Schools of the United States," by Leverett S. Lyon instructor in the School of Commerce and Administration of the University of Chicago.

In the earlier sections of the monograph the following topics are discussed in detail: the kinds of commercial courses in public high schools, the length of such courses, the required subjects in each course, and the relative importance of technical and content subjects in commercial courses.

Inasmuch as the study is based on an investigation of commercial education in one hundred and thirty-six high schools in twenty-six different states, it is the most extensive study of its kind which has yet been made. Special consideration is given in the monograph to the social-business subjects. Such discussions are particularly appropriate in view of the increased importance, during recent years, to the business world of a thorough knowledge of commercial organization, economics, accounting, commercial law, and business organization.

One of the final chapters entitled "Plans and Policies in Secondary Commercial Work" discusses the significant needs of commercial education in a thoroughly constructive way. The monograph will prove very suggestive to superintendents and high-school principals who have supervision of commercial courses. It should be read by teachers of all phases of commercial education.—*School Review.*

LARGE STEEL MANUFACTURER DECLARES METRIC STANDARDIZATION EASY; NOT EXPENSIVE.

Speaking for one of the large steel manufacturing companies of the United States, R. H. Page, Vice-President of the Truscon Steel Company, New York City, and Manager of the Foreign Trade Department of the Truscon Steel Co., of Youngstown, Ohio, has just declared to the World Trade Club of San Francisco, that in the steel industry, the advance to metric standardization could be made easily and without appreciable cost. Mr. Page declares that his company strongly favors the adoption of metric standards exclusively by the U. S. of America. He asserts that foreign transactions would be greatly simplified by dealing in metric units and that the foreign trade of the United States would be greatly advanced.

He declares that there are no real difficulties in the way of adoption of metric standards. "The heavy equipment in the basic industries—such as rolls in the steel industry—are of short life and could be entirely replaced with metric sizes in 2 or 3 years' time," he declares. "The more complex tools and dies would require somewhat longer to replace, but, meanwhile, the products thereof could be listed in their present metric equivalents. Many of our larger firms in certain lines already maintain duplicate equipment for the manufacture of metric sizes for their foreign markets, thus recognizing the importance of getting into step with the majority of the civilized nations."

Some of the other large steel manufacturers supporting metric standardization are: R. T. Crane of the Crane Co., Chicago; The Tacony Steel Co. of Philadelphia; The Victor Animatograph Co. of Davenport, Iowa; Standard Steel Car Co., Butler, Pa.; Hamilton Watch Co., Lancaster, Pa.; American Wire Fabrics Co., Chicago, Ill.; The Hydraulic Pressed Steel Co. of Cleveland, Ohio; The American Insulated Wire & Cable Co., of Chicago, Ill., etc.

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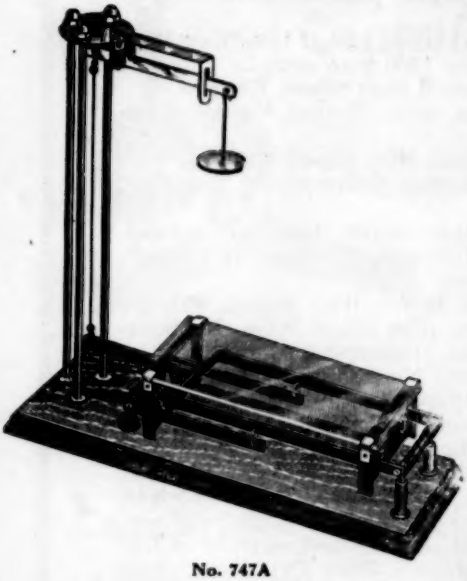

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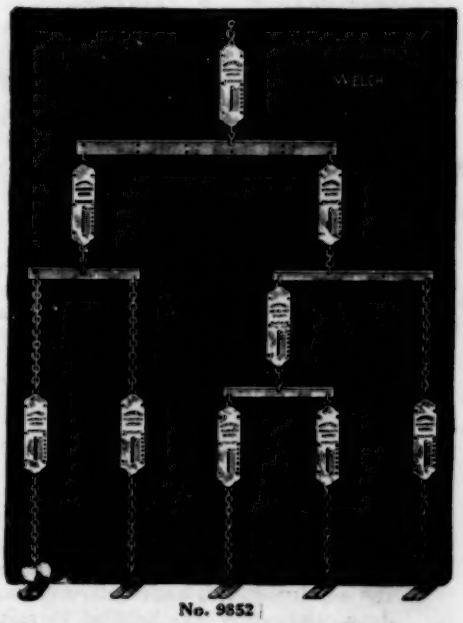

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CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

At the November meeting of this Association held at Lake View High School, Chicago, the following officers for 1920 were elected:

President—J. A. Foberg, Crane Technical High School, Chicago.

Vice-President—Frederick R. Gorton, State Normal College, Ypsilanti, Mich.

Treasurer—Lewis L. Hall, Morgans Park High School, Chicago.

Corresponding Secretary—Ally L. Marlatt, University of Wisconsin, Madison.

Assistant Treasurer—E. S. Tillman, High School, Hammond, Indiana.

The Recording Secretary, Harry O. Gillet, the University of Chicago, was elected last year for a two-year term.

Biology—Chairman, Grace J. Baird, Bowen High School, Chicago; V. Chairman, C. P. Shideler, Joliet Twp. High School, Joliet, Ill., Secretary, Elizabeth Foss, North High School, Minneapolis, Minn.

Chemistry—Chairman, B. J. Rivett, Northwestern High School, Detroit, Mich,; V. Chairman, George Sype, Austin High School, Chicago; Secretary, K. J. Stouffer, Wayland Academy, Beaver Dam, Wis.

General Science—Chairman, G. A. Bowden, University School, Cincinnati, Ohio; V. Chairman, George Mounce, LaSalle-Peru Twp. High School, LaSalle, Ill.; Secretary, Ruth C. Russell, Lake View High School, Chicago.

Geography—Chairman, Wellington D. Jones, The University of Chicago, Chicago; V. Chairman, R. R. Robinson, Joliet Twp. High School, Joliet, Ill.; Secretary, Anne B. Royeston, Hyde Park High School, Chicago.

Home Economics—Chairman, Harriet Glendon, Lewis Institute, Chicago; V. Chairman, Treva E. Kauffman, Ohio State University, Columbus, Ohio; Secretary, Maude M. Firth, Supervisor Home Econ., Davenport, Ia.

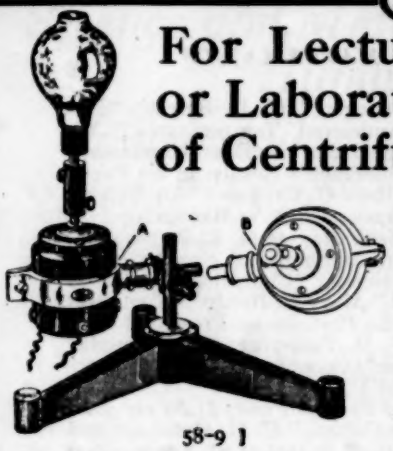
Mathematics—Chairman, M. J. Newell, High School, Evanston, Ill.; V. Chairman, W. E. Beck, High School, Iowa City, Iowa; Secretary, Elsie G. Parker, Oak Park High School, Oak Park, Ill.

Physics—Chairman, H. Clyde Krenerick, North Div. High School, Milwaukee, Wis.; V. Chairman, C. F. Phipps, State Normal School, DeKalb, Ill.; Secretary, Glenn W. Warner, Englewood High School, Chicago.

The reports of the various sections' meetings will appear in the March issue of this Journal. They will make a very complete and comprehensive review of the entire transactions of the recent convention. The next meeting will be held in Chicago.

Recently, engineers, assembled from all parts of the world, celebrated the one hundredth anniversary of the death of James Watt. The three days celebration was held at Birmingham, England, where Watt lived and died. To his genius are due the steam engine, steam pump, steam railway and steam turbine. But Watt himself considered his greatest achievement the invention of a decimal measuring system whose three principal units became meter-liter-gram.

The strong movement on foot in America at the present time for the exclusive use of these rational units in the United States is a belated tribute to the genius of this great man.



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ARTICLES IN CURRENT PERIODICALS.

American Botanist, for November; *Joliet, Ill.; $1.25 per year, 35 cents a copy:* "Plant Names and Their Meanings," Willard N. Clute; "A Little Known Botanist," J. E. Nelson; "The Haunts of a Naturalist," H. Tullsen.

American Journal of Botany, for November; *Brooklyn Botanic Garden, $5.00 per year, 60 cents a copy:* "A Study of Some Factors in the Chemical Stimulation of the Growth of Aspergillus Niger (Concluded)," Robert Aaron Steinberg; "An Index of Hardiness in Peach Buds," Earl S. Johnston; "Notes on the Dasheen and Chayote," Heber W. Youngken; "The Development of the Gametophyte and the Distribution of Sexual Characters in Funaria Hygrometrica," Mabel Mary Brown.

American Naturalist, for November-December; *Garrison, N. Y.; $5.00 per year, $1.00 a copy:* "Inheritance of White Spotting and Other Color Characters in Cats," P. W. Whiting; "Some Habitat Responses of the Large Water Strider Gerris Remigis Say," C. L. C. Riley; "Behavior and Assimilation," Henry D. Hooker, Jr.; "On the Use of the Sucking-fish for catching Fish and Turtles," E. W. Gudger; "Variability in Flower-number in Vernonia Missurica Rof," H. A. Gleason.

Condor, for November-December; *University of California, Berkeley: $2.00 per year, 40 cents a copy:* "Bird Notes from Saskatchewan," H. H. Mitchell; "A Return to the Dakota Lake Region," Florence M. Bailey; "Notes on the Elegent Tern as a Bird of California," Joseph Grinnell.

Journal of Physical Chemistry, for December; *Ithaca, N. Y.; $4.00 per year:* "Some Studies in Fondant Making," Mary S. Carrick; "The Colors of Colloids," Wilder D. Bancroft; "Emulsification at an Oil-Water Interface," "The Effect of Chlorine on Periodic Precipitation," Miss A. W. Foster.

Physical Review, for November; *Ithaca, N. Y.; $7.00 per year, 75 cents a copy:* "On the Distribution of Energy in the Visible Spectrum of an Acetylene-Flame," E. P. Hyde, W. E. Forsythe and F. E. Cady; "On the Spectrum of X-Rays from an Aluminum Target," William Duane and Takeo Shimizu; "Studies of the Absorption of Gases by Charcoal, II," Harvey B. Lemon and Kathryn Blodgett; "The End Correction in the Determination of Gas Viscosity by Capillary Tube Method," A. F.

Benton; "The Radiating Potentials of Nitrogen," H. D. Smyth; "The Reflection Factors of Tungsten at Incandescent Temperatures," W. Weniger and A. H. Pfund; "Reflection of Electrons from Metal Surfaces," H. H. Dadourian; "Remarks on Dr. L. Silberstein's Results in his Paper 'On the Dispersion of the Diamond,'" Albert C. Crehore; "An Experimental Method for the Production of Vibrations," C. V. Raman.

Popular Astronomy, for January; *Northfield, Minnesota; $4.00 per year:* "Twenty-Third Meeting of the American Astronomical Society (Concluded)"; "The Reform of the Julian Calendar (Continued)," Roscoe Lamont; "First Study of Heavenly Bodies," Mary E. Byrd; "A Criticism of Pickering's Suggested Explanation of the Phenomena Presented by a Nova," A. C. Gifford, with Reply by W. H. Pickering; "The Annular Eclipse of November 22, 1919. The Lunar Atmosphere," W. H. Pickering; "Astronomical Phenomena in 1920."

School Review, for January; *University of Chicago Press; $1.50 per year, 20 cents a copy:* "Some Aspects of a Junior College," C. C. Alexander and G. W. Willett; "The Ben Blewett Junior High School of St. Louis—Part I," R. L. Lyman; "A Failure Class in Algebra," O. A. Wood; "The Social Life of High-School Girls: Its Problems and Its Opportunities," Olivia Pound; "A High-School Program for Training in Citizenship," Thomas Warrington Gosling.

Scientific Monthly, for January; *Garrison, N. Y.; $5.00 per year, 50 cents a copy:* "Defects Found in Drafted Men," Dr. C. B. Davenport and Lieutenant Colonel Albert G. Love; "The Haven of Health," Dr. George E. Simpson; "The Disadvantages of Being Human," Professor B. W. Kunkel; "The Mechanism of Evolution in the Light of Heredity and Development," Professor Edwin G. Conklin; "Growing Plants as Health-Giving Agents," Dr. James Anders; "The Microscopic Identification of Commercial Fur Hairs," Dr. Leon A. Hausman; "The Deflection of Light by Gravitation and the Einstein Theory of Relativity"; "The Origins of Civilization," Professor James H. Breasted.

EDUCATIONAL NOTES.

It is a matter of common knowledge that the increased cost of production of to-day is in large measure due to the demand on the part of labor for shorter working hours and more pay. The common way of the manufacturer of meeting this increased cost has been to pass it all and a little more on to the consumer by greatly raising the price of the commodity.

At the Athenaeum Press, where Ginn and Company's books are manufactured, there has just been inaugurated a plan of training foremen, forewomen, and other factory supervisors in production methods. A three-months' course is being conducted by the Business Training Corporation of New York for a group of forty-six, composed of the treasurer, press manager, department heads, and all foremen from the man in charge of a room of fifty to the one who supervises the work of two or three. The work consists in the study of especially prepared subjects, the solution of problems relating to each subject, and the discussion of this material at six bi-weekly meetings. At each meeting a lecture is delivered by an experienced production man. Afterward the meeting is thrown open to discussion of the material set forth in the text, and problems which may be peculiar to any particular branch of work in the plant. The subjects covered are teamwork, handling men, machinery and materials, organization, production records and management.

Beside a more thorough all-round knowledge of production methods, the course gives an opportunity for the leaders in the Press to get together, discuss important problems, not only among themselves, but with the higher executives, and to acquire at first hand the spirit of unity and team play which in the last analysis means the elimination of unrest.

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BOOKS RECEIVED.

A First Book in Algebra, by Fletcher Durell, Lawrenceville School, and E. E. Arnold, Pelhams, N. Y., pages v+325+xxxix. 13×19 cm. Cloth. 1919. Charles E. Merrell Company, Chicago, Ill.

Div-A-Set, Division by letters, by W. H. Vail, Newark, N. J. 70 pages 12×20 cm. Paper. 50 cents. W. H. Vail, 141 Second Ave., Newark, N. J.

Illinois' State Geological Survey. Geology and Mineral Resources of the Hennepin and La Salle Quadrangles, by Gilbert H. Cachy. 136 pages. 17.5×26 cm. Cloth. 1919. The State Geological Survey, Urbana, Ill.

Brightness and Dullness in Children by Herbert Woodrow, University of Minnesota. 322 pages. 12.5×19 cm. Cloth. 1919. J. B. Lippincott Company, Philadelphia, Pa.

Publications of the United States Government:

Treasury Department Bulletin No. 41. The Place of Sex Education in Biology and General Science.

Department of the Interior Statement of the Commissioner of Education to the Secretary of the Interior for the Year Ending June 30, 1919.

Department of the Interior, Bureau of Education, Bulletin No. 28. 1919—Educational Periodicals During the Nineteenth Century. Bulletin No. 46. 1919—Bibliography of Home Economics. Bulletin No. 75. 1919—Monthly Record of Current Educational Publications. Bulletin No. 56. 1919—The Administration of Correspondence-Study Departments of Universities and Colleges. Bulletin No. 6. 1919—A Half-Time Mill School. Bulletin No. 74. 1919—Federal Executive Departments as sources of information for libraries. Bulletin No. 35. 1919—The Junior College. Bulletin No. 2. 1919—Standardization of Medical Inspection Facilities. Bulletin No. 71. 1919—Educational Directory, 1919-20, Part 4, Special Schools. Bulletin No. 68. 1919—Financial and Building Needs of the Schools of Lexington, Kentucky.

GYPSUM IN 1918.

The annual report on gypsum by the United States Geological Survey, Department of the Interior, has just been issued. This report contains statistics of production by States and by uses, imports, and exports, mention of the quantities of gypsum products used by Government organizations in housing operations for war use, a new description of the gypsum deposit in Florida, and lists of manufacturers of the principal gypsum products. A copy may be obtained free on application to the Director, United States Geological Survey, Washington, D. C.

GEOLOGY FURNISHES KEY TO THE CONSERVATION OF WATER.

The geologic history of the region furnishes the key to the conservation of its water supply. The sea has not always stood at the same level with reference to the land. In past geologic epochs it stood at different levels, and here from age to age it cut cliffs and terraces which are today the most conspicuous physical features of the coastal belt. In this belt there are several distinct terraces, the highest as much as 1,100 feet above the present sea level, and some of these terraces still bear well-preserved ancient beach ridges. But at some time in the geologic past the sea stood lower with reference to the land than it does today, and this fact has determined the quantity of water now stored in the ground in this region. When the sea stood lower or the land stood higher the streams that flowed from the mountains to the sea cut deep valleys into the coastal belt, and when the sea rose to its present level the streams quickly filled these valleys with porous deposits of gravel and sand, and these now form great subterranean reservoirs which hold the flood waters that are poured into them from the mountains.

BOOK REVIEWS.

The Blind, Their Condition, and the Work Being Done for Them in United States, by Harry Best. Pages xxviii+763. 13.5×20 cm. Cloth. 1919. Macmillan Company, New York City.

This book is without question one of the very best that has recently come from the printers, bearing upon the subject of the blind. The author is more than well versed in the subject and has brought together a mass of facts and data the like of which has never been compiled.

The book considers the blind with respect to the United States, almost entirely except as some of the causes for blindness may have been contributed by foreign countries.

The book is divided into seven parts. Part one is devoted to the general condition of the blind, part two, blindness and possibilities for its prevention, with six chapters, part three, provision for education of blind discussed in fourteen chapters, part four, intellectual provision for adult blind with four chapters, part five, material provision for the blind discussed in thirteen chapters, part six, organizations interested in the blind with three chapters, part seven conclusion, with respect to the work for the blind, one chapter. There are four appendices and a most complete index.

The author makes very profuse use of all articles and books with information bearing upon this subject, mention and reference being made to the various sources. Until comparatively recently the attitude of society toward the blind has been chiefly one of compassion, but if this work can be circulated among our influential men and women the country will be brought to a deep realization of the fact that strenous measures must be taken to reduce causes of blindness. C. H. S.

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Teaching Home Economics, by Anna M. Cooley, Cora Winchell, Wilhelmina H. Spohr, and Josephine A. Marshall, Teachers College, Columbia University, New York City. Pages vii+555. 13.5×20 cm. Cloth. 1919. $1.80. Macmillan Company, New York City.

The fundamental purpose of this book is to offer suggestions for the organization, administration, and teaching of all subjects bearing on Home Economics and with this thought in mind the authors have endeavored to adapt it to the needs of all classes of people whose needs they hope to serve. There is no question at this day and age of what every girl should know, her education should be devoted considerably to the subject of Home Economics. She needs this because she should know how to be able to live a more healthful life, rear her children intelligently, and serve her community.

This book is intended primarily to be used as a text in normal schools and colleges. It is divided into five parts. Part one, being devoted to Home Economics as a recognized study in the school program, five splendid chapters discussing this; part two, Courses in Study in Home Economics being thoroughly discussed in five chapters; part three, Lessons in Home Economics, the matter being presented in four complete chapters; part four, personal materials and opportunities in teaching Home Ecomics, the matter being clearly presented in four chapters; part five, is an addenda of various kinds. There is also a very complete index of nine double-columned pages.

The book is splendidly written and will make good reading for the laywoman. A splendid bibliography is given too. Many chapters close with suggestions for review and references for further reading. Every Home Economics teacher in the country should possess a copy. C. H. S.

Applied Science for Wood Workers by Wm. H. Dooley, Principal of North Textile School, New York City. Pages x+457. 13×19 cm. Cloth. 1919. The Ronald Press Company, New York City.

This book is a companion volume of the "Metal Working Trades." There is no question but what every mechanic or tradesman should be trained as thoroughly as possible in the handicraft of his trade. But if he is to be a skilled worker he should have considerable knowledge of the scientific principles involved and should know the reasons why certain operations in his trade should take place. Knowledge can be secured, however, by him in becoming conversant with good texts, such as this one. The knowledge here gained with his experience will enable him to be a better and more efficient workman.

The book is of such nature and character that it is well adapted for teachers in secondary and technical schools and by science teachers in the vocational schools. It is splendidly written, clear, and to the point. There are thirty-five chapters, each of which not only begin with bold face type but give the reader an idea of what is discussed in it. Each chapter closes with a splendid list of suggested questions. There are two hundred and six drawings and views, all splendidly executed. All persons interested in wood should have a copy of this most valuable book. C. H. S.

Applied Science for Metal Workers by Wm H. Dooley, Principal of North Textile School, New York City. Pages x+479. 13×19 cm. Cloth. 1919.

All that has been said with reference to the book "Applied Science for Wood Workers" is true of this book. It deserves a large sale. Every metal worker should possess a copy. C. H. S.

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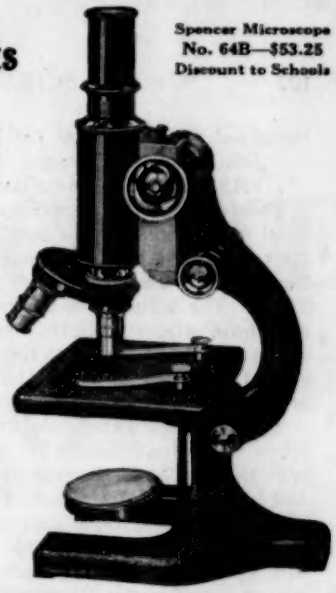

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Principal of Agriculture for High Schools, by John H. Gehrs, Normal School, Cape Girardeau, Mo. Pages x+594. 13.5×19 cm. Cloth. 1919. $2.25. Macmillan Company, New York City.

The fundamental purpose of this text is to demonstrate how agricultural production may be increased. As all students of this subject know, the products of the farm have not kept pace with the increase in population. This is an important factor which has helped to increase the cost of living. The influence of books of this character on our farming population and those interested in this subject will surely assist in increasing the products of the soil and thus reducing the price of food stuff. Every farmer should study his farm soil thus determining what crops he should raise in order to give him increased returns.

The book is divided into five sections. Section one is devoted to farm crops where major crops are discussed, section two, to farm animals, and here the matter is thoroughly dealt with; section three, devoted to soils, and is a splendid discussion of them; section four, devoted to horticulture; and section five, farm management; this is an important phase of the work as there are already too many farmers who have very little conception of what real farm management is. Nearly every chapter finishes with a set of pertinent questions.

The book makes interesting reading to any man or woman who is a lover of the country. There are over two hundred drawings and halftones in the text. C. H. S.

A Handbook of American Private Schools, and Annual Survey 5th edition, by Porter Sargent. Pages 768. 13×8.5 cm. Cloth. 1919. Porter Sargent, 14 Bacon St., Boston.

There is not space enough to write an eulogy or a review of this splendid book, too much cannot be said concerning its real worth. It is an encyclopaedia on the private schools of the United States and Canada, and anyone wanting information concerning almost any private school in these two countries will find it given in this volume. Parents contemplating sending their children away to school, if they desire a private school, can secure no better information than by referring to this book. All schools should have a copy of the book in their libraries. The author should surely be congratulated on the splendid volume he has put out. C. H. S.

Engineering Application of Higher Mathematics, by V. Karapeloff, Cornell University. Four parts, all 14×21 cm. Cloth. 75c each. Part I pages v+101, part II pages v+112, part III pages v+79, part IV pages vi+64. John Wiley and Sons, New York City.

These four books although they do not contemplate an exhausted treatment of the subject are complete within themselves. The matter is handled in a most interesting way and to the student who has had previous mathematical training, therefore is equipped for this kind of work, will find in these four volumes matter which will be of the greatest help to him. The topics treated are typical in engineering work. The drawings are extraordinarily clear and well made. Throughout the body of the books numerous problems are given. The books were primarily for use in engineering schools. All engineering students and instructors would do well to possess copies. C. H. S.

Examples in Magnetism, by F. E. Austin. Pages 90. 12×19cm. Leather. 1916. F. E. Austin, Hanover, New Hampshire.

A splendid little hand book for laboratory work in magnetism for secondary schools. Contains many examples and many exercises as well as questions upon magnetism. A little text that all Physics teachers should possess. C. H. S.